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PAEDIATRIC NUTRITION

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SYLLABI-BOOK MAPPING TABLE

Paediatric Nutrition

Syllabi	Mapping in Book
BLOCK-I: NUTRITION IN INFANCY AND IMMUNIZATION SCHEDULES **UNIT 1** Infancy - Physiological Development, Assessment of Nutritional Status. **UNIT 2** Anthropometric Measurements, Biochemical Parameters, Clinical & Dietary Data of Infants. **UNIT 3** Nutritional and Food Requirements for Infants. **UNIT 4** Immunization Schedule during Pregnancy, Infancy and Childhood.	**Unit-1:** Infancy and Physiological Development **(Pages 1-16);** **Unit-2:** Anthropometric Measurements and Biochemical Parameters **(Pages 17-30);** **Unit-3:** Nutritional and Food Requirements for Infants **(Pages 31-43);** **Unit-4:** Immunization Schedule **(Pages 44-59)**
BLOCK-II: NUTRITIONAL MANAGEMENT OF INFANTS AND NEWBORN SICKNESS **UNIT 5** Nutritional Management of Premature Baby, Low Birth Weight Babies and Children with Developmental Disabilities. **UNIT 6** Infant Lactation- Characteristics, Causes and Complications, Feeding Methods, Growth and Nutritional Assessment of Infant's Lactation. **UNIT 7** Identification of Newborn Sickness - Detection of Abnormal Signs - Cyanosis, Jaundice, Respiratory Distress. **UNIT 8** Bleeding, Seizures, Refusal and Feed, Abdominal Distention, Failure to Pass Meconium and Urine of Sick Newborn.	**Unit-5:** Nutritional Management **(Pages 60-82);** **Unit-6:** Infant Lactation **(Pages 83-105);** **Unit-7:** Identification of Newborn Sickness **(Pages 106-116);** **Unit-8:** Problems of Newborn Sick **(Pages 117-129)**
BLOCK-III: CLINICAL NUTRITION IN INFANTS **UNIT 9** Nutritional Management in Malnutrition - Protein-Energy Malnutrition (PEM), Anaemia, Scurvy, Rickets, Vitamin A Deficiency, Obesity of Childhood. **UNIT 10** Underweight and Underweight Nutrition - Short Term and Long Term Consequences in Infants. **UNIT 11** Nutritional Management of Diarrhoea, Typhoid, TB and Hepatitis of Infants.	**Unit-9:** Nutritional Management in Malnutrition and Obesity **(Pages 130-155);** **Unit-10:** Nutrition for Underweight Child **(Pages 156-176);** **Unit-11:** Nutritional Management of Diarrhoea, Typhoid, Tuberculosis and Hepatitis of Infants **(Pages 177-197)**

BLOCK-IV: NUTRITIONAL MANAGEMENT FOR CHILDREN WITH SPECIAL CONDITIONS

UNIT 12

Lactose Intolerance, Celiac Disease, Inflammatory Bowel Disease, Constipation and Fat Absorption, Test Diet of Infants. (Calculation of Fluids & Electrolytes - Both Deficit and Maintenance and Management of Calorie Intake).

UNIT 13

Nutritional Management for Children with Special Conditions - Autism and ADH (Attention Deficit Hyperactivity Disorder), Epilepsy and AIDS.

UNIT 14

Measuring, Recording and Plotting Growth of Infants.

Unit-12: Management of Fluids and Electrolytes
(Pages 198-223);
Unit-13: Nutritional Management for Children with Special Conditions
(Pages 224-242);
Unit-14: Measuring and Plotting Growth of Infants
(Pages 243-276)

CONTENTS

INTRODUCTION

BLOCK I: NUTRITION IN INFANCY AND IMMUNIZATION SCHEDULES

UNIT 1 INFANCY AND PHYSIOLOGICAL DEVELOPMENT 1-16

1.0 Introduction
1.1 Objectives
1.2 Physiological Development of Infants
1.3 Nutritional Assessment
1.4 Answers to Check Your Progress Questions
1.5 Summary
1.6 Key Words
1.7 Self Assessment Questions and Exercises
1.8 Further Readings

UNIT 2 ANTHROPOMETRIC MEASUREMENTS AND BIOCHEMICAL PARAMETERS 17-30

2.0 Introduction
2.1 Objectives
2.2 Anthropometric Measurements, Biochemical Parameters, Clinical and Dietary Data of Infants
2.2.1 Anthropometric Measurements
2.2.2 Biochemical Parameters
2.2.3 Clinical Data of Infants
2.2.4 Dietary Data of Infants
2.3 Answers to Check Your Progress Questions
2.4 Summary
2.5 Key Words
2.6 Self Assessment Questions and Exercises
2.7 Further Readings

UNIT 3 NUTRITIONAL AND FOOD REQUIREMENTS FOR INFANTS 31-43

3.0 Introduction
3.1 Objectives
3.2 Nutritional and Food Requirements for Infants
3.3 Answers to Check Your Progress Questions
3.4 Summary
3.5 Key Words
3.6 Self Assessment Questions and Exercises
3.7 Further Readings

UNIT 4 IMMUNIZATION SCHEDULE 44-59

4.0 Introduction
4.1 Objectives
4.2 Immunization Schedule During Pregnancy, Infancy and Childhood
4.2.1 Immunization Schedule During Pregnancy
4.2.2 Immunization in Infants
4.2.3 Immunization in Children
4.3 Answers to Check Your Progress Questions
4.4 Summary
4.5 Key Words
4.6 Self Assessment Questions and Exercises
4.7 Further Readings

BLOCK II: NUTRITIONAL MANAGEMENT OF INFANTS AND NEWBORN SICKNESS

UNIT 5 NUTRITIONAL MANAGEMENT 60-82

5.0 Introduction
5.1 Objectives
5.2 Nutritional Management of Premature Baby, Low Birth Weight Babies and Children with Developmental Disabilities
5.2.1 Nutritional Management of Premature Baby
5.2.2 Nutrition for Low Birth Weight Infant
5.2.3 Nutrition in Infants with Developmental Disabilities
5.3 Answers to Check Your Progress Questions
5.4 Summary
5.5 Key Words
5.6 Self Assessment Questions and Exercises
5.7 Further Readings

UNIT 6 INFANT LACTATION **83-105**

6.0 Introduction
6.1 Objectives
6.2 Infant Lactation its Characteristics, Causes and Complications
6.2.1 Characteristics of Breastfeeding
6.2.2 Causes and Complications of Breastfeeding
6.3 Growth and Nutritional Assessment of Infant's Lactation and their Feeding Methods
6.3.1 Breastfeeding Methods: Rectified and Improvisations
6.4 Answers to Check Your Progress Questions
6.5 Summary
6.6 Key Words
6.7 Self Assessment Questions and Exercises
6.8 Further Readings

UNIT 7 IDENTIFICATION OF NEWBORN SICKNESS **106-116**

7.0 Introduction
7.1 Objectives
7.2 Identification of Newborn Sickness
7.2.1 Detection of Jaundice in Newborn
7.2.2 Cyanosis or Respiratory Distress in Newborn
7.2.3 Detection of Respiratory Distress Syndrome in Newborn
7.3 Answers to Check Your Progress Questions
7.4 Summary
7.5 Key Words
7.6 Self Assessment Questions and Exercises
7.7 Further Readings

UNIT 8 PROBLEMS OF NEWBORN SICK **117-129**

8.0 Introduction
8.1 Objectives
8.2 Newborn Illness: Bleeding, Seizures, Refusal and Feed, Abdominal Distention, Failure to Pass Meconium and Urine
8.2.1 Bleeding
8.2.2 Seizure
8.2.3 Refusal to Feed
8.2.4 Failure to Pass Meconium and/or Urine
8.2.5 Abdominal Distention
8.3 Answers to Check Your Progress Questions
8.4 Summary
8.5 Key Words
8.6 Self Assessment Questions and Exercises
8.7 Further Readings

BLOCK III: CLINICAL NUTRITION IN INFANTS

UNIT 9 NUTRITIONAL MANAGEMENT IN MALNUTRITION AND OBESITY **130-155**

9.0 Introduction
9.1 Objectives
9.2 Nutritional Management in Malnutrition
  9.2.1 Protein-Energy Malnutrition (PEM)
  9.2.2 Obesity in Children
  9.2.3 Rickets in Children
  9.2.4 Anemia in Children
  9.2.5 Scurvy
  9.2.6 Vitamin a Deficiency
9.3 Answers to Check Your Progress Questions
9.4 Summary
9.5 Key Words
9.6 Self Assessment Questions and Exercises
9.7 Further Readings

UNIT 10 NUTRITION FOR UNDERWEIGHT CHILD **156-176**

10.0 Introduction
10.1 Objectives
10.2 Underweight and Underweight Nutrition and its Short and Long Term Consequences in Infants
10.3 Answers to Check Your Progress Questions
10.4 Summary
10.5 Key Words
10.6 Self Assessment Questions and Exercises
10.7 Further Readings

UNIT 11 NUTRITIONAL MANAGEMENT OF DIARRHOEA, TYPHOID, TUBERCULOSIS AND HEPATITIS OF INFANTS **177-197**

11.0 Introduction
11.1 Objectives
11.2 Nutritional Management of Diarrhoea, Typhoid, Tuberculosis and Hepatitis for Infants
  11.2.1 Nutritional Management of Diarrhoea
  11.2.2 Nutritional Management of Typhoid
  11.2.3 Tuberculosis (TB) In Infants
  11.2.4 Nutritional Management of Hepatitis

11.3 Answers to Check Your Progress Questions
11.4 Summary
11.5 Key Words
11.6 Self Assessment Questions and Exercises
11.7 Further Readings

BLOCK IV: NUTRITIONAL MANAGEMENT FOR CHILDREN WITH SPECIAL CONDITIONS

UNIT 12 MANAGEMENT OF FLUIDS AND ELECTROLYTES 198-223

12.0 Introduction
12.1 Objectives
10.2 Lactose Intolerance, Celiac Disease, Inflammatory Bowel Disease, Constipation and Fat Absorption Test Diet of Infants
12.2.1 Lactose Intolerance and Celiac Disease
12.2.2 Inflammatory Bowel Disease (IBD)
12.2.3 Constipation and Fat Absorption Test Diet of Infants
12.2.4 Calculation of Fluids and Electrolytes: Both Deficit and Maintenance and Management of Calorie Intake
12.3 Answers to Check Your Progress Questions
12.4 Summary
12.5 Key Words
12.6 Self Assessment Questions and Exercises
12.7 Further Readings

UNIT 13 NUTRITIONAL MANAGEMENT FOR CHILDREN WITH SPECIAL CONDITIONS 224-242

13.0 Introduction
13.1 Objectives
13.2 Nutritional Management for Children with Special Conditions
13.2.1 Nutrition Management in Autism
13.2.2 Nutrition Management in Epilepsy
13.2.3 Nutrition for HIV/AIDS Infected Infants and Children
13.2.4 Nutrition Management in ADH
13.3 Answers to Check Your Progress Questions
13.4 Summary
13.5 Key Words
13.6 Self Assessment Questions and Exercises
13.7 Further Readings

UNIT 14 MEASURING AND PLOTTING GROWTH OF INFANTS 243-276

14.0 Introduction
14.1 Objectives
14.2 Measuring, Recording and Plotting Growth of Infants
14.3 Answers to Check Your Progress Questions
14.4 Summary
14.5 Key Words
14.6 Self Assessment Questions and Exercises
14.7 Further Readings

INTRODUCTION

NOTES

Pediatrics, also spelled paediatrics or pædiatrics, is the branch of medicine that involves the medical care of infants, children, and adolescents. The American Academy of Pediatrics recommends people seek pediatric care through the age of 21. In the United Kingdom, paediatrics covers patients until age 18. Worldwide age limits of pediatrics have been trending up year over year. A medical doctor who specializes in this area is known as a pediatrician, or paediatrician. The word pediatrics and its cognates mean "Healer of Children". Pediatricians work in hospitals and children's hospitals particularly those working in its subspecialties (e.g., neonatology), and as outpatient primary care physicians.

Infant nutrition is the description of the dietary needs of infants. A diet lacking essential calories, minerals, vitamins, or fluids is considered inadequate. Breast milk provides the best nutrition for these vital first months of growth when compared to infant formula. For example, breastfeeding aids in preventing anemia, obesity, and sudden infant death syndrome; and it promotes digestive health, immunity, intelligence, and dental development. The American Academy of Pediatrics recommends exclusively feeding an infant breast milk, or iron fortified formula, for the first six months of life and continuing for one year or longer as desired by infant and mother. Infants are usually not introduced to solid foods until four to six months of age. Historically, breastfeeding infants was the only option for nutrition otherwise the infant would perish. Breastfeeding is rarely contraindicated, but is not recommended for mothers being treated for cancer, those with active tuberculosis, HIV, substance abuse, or leukemia. Clinicians can be consulted to determine what the best source of infant nutrition is for each baby.

Proper infant nutrition demands providing essential substances that support normal growth, functioning, development, and resistance to infections and diseases. Optimal nutrition can be achieved by the expectant mother making the decision to breastfeed or bottle-feed the infant before birth and preparing for chosen decision.

Undernutrition in children, occurs when children do not consume enough calories, protein, or micronutrients to maintain good health. It is common globally and may result in both short and long term irreversible adverse health outcomes. Undernutrition is sometimes used synonymously with malnutrition, however, malnutrition could mean both undernutrition or overnutrition (causing childhood obesity). The World Health Organization (WHO) estimates that malnutrition accounts for 54 percent of child mortality worldwide, which is about 1 million children. Another estimate, also by WHO, states that childhood underweight is the cause for about 35% of all deaths of children under the age of five worldwide.

Malnutrition is a condition that results from eating a diet which does not supply a healthy amount of one or more nutrients. This includes diets that have too little nutrients or so many that the diet causes health problems. The nutrients involved

NOTES

can include calories, protein, carbohydrates, fat, vitamins or minerals. A lack of nutrients is called undernutrition or undernourishment while a surplus of nutrients cases overnutrition. Malnutrition is most often used to refer to undernutrition - when an individual is not getting enough calories, protein, or micronutrients. If undernutrition occurs during pregnancy, or before two years of age, it may result in permanent problems with physical and mental development. Extreme undernourishment, known as starvation or chronic hunger, may have symptoms that include: a short height, thin body, very poor energy levels, and swollen legs and abdomen.

This book, *Paediatric Nutrition*, is divided into four blocks, which are further subdivided into fourteen units. This book provides a basic understanding of the subject and helps to grasp its fundamentals. In a nutshell, it explains various aspects, such as nutrition in infancy and immunization schedules, infancy - physiological development, assessment of nutritional status, Anthropometric measurements, biochemical parameters, nutritional and food requirements for infants, immunization schedule during pregnancy, infancy and childhood, nutritional management of infants and newborn sickness, nutritional management of premature baby, low birth weight babies and children with developmental disabilities, infant lactation, identification of newborn sickness, detection of abnormal signs, cyanosis, jaundice, respiratory distress, bleeding, seizures, refusal and feed, abdominal distention, nutritional management in malnutrition, Protein–Energy Malnutrition (PEM), anaemia, scurvy, rickets, vitamin a deficiency, obesity of childhood, underweight and underweight nutrition, nutritional management of diarrhoea, typhoid, TB and hepatitis of infants, and nutritional management for children with special conditions.

The book follows the Self-Instructional Mode (SIM) wherein each unit begins with an 'Introduction' to the topic. The 'Objectives' are then outlined before going on to the presentation of the detailed content in a simple and structured format. 'Check Your Progress' questions are provided at regular intervals to test the student's understanding of the subject. 'Answers to Check Your Progress Questions', a 'Summary', a list of 'Key Words', and a set of 'Self-Assessment Questions and Exercises' are provided at the end of each unit for effective recapitulation.

BLOCK - I

NUTRITION IN INFANCY AND IMMUNIZATION

NOTES

UNIT 1 INFANCY AND PHYSIOLOGICAL DEVELOPMENT

Structure

1.0 Introduction
1.1 Objectives
1.2 Physiological Development of Infants
1.3 Nutritional Assessment
1.4 Answers to Check Your Progress Questions
1.5 Summary
1.6 Key Words
1.7 Self Assessment Questions and Exercises
1.8 Further Readings

1.0 INTRODUCTION

Psychological development is the development of human beings cognitive, emotional, intellectual and social capabilities and functioning over the course of a normal life span, from infancy through old age. It is the subject matter of the discipline known as developmental psychology. Child psychology was the traditional focus of research, but since the mid of 20th century much has been learned about infancy and adulthood as well.

Infancy is the period between birth and the acquisition of language one to two years later. Besides a set of inherited reflexes that help them obtain nourishment and react to danger, newborns are equipped with a predilection for certain visual patterns, including that of the human face, and for certain sounds, including that of the human voice. Within a few months they are able to identify their mothers by sight, and they show a striking sensitivity to the tones, rhythmic flow, and individual sounds that make up human speech. Even young infants are capable of complex perceptual judgments involving distance, shape, direction, and depth, and they are soon able to organise their experience by creating categories for objects and events, for example people, furniture, food, animals in the same way older people do.

In this unit, you will study about physiological development of infants and assessment of nutritional status.

NOTES

1.1 OBJECTIVES

After going through this unit, you will be able to:

- Explain the physiological development of infants
- Analyse the assessment of nutritional status

1.2 PHYSIOLOGICAL DEVELOPMENT OF INFANTS

Infancy is the first year of a human child. An infant is dependent on parents for nourishment and nurturing. As this phase sees a rapid growth in the baby's physical milestones the 1000 days from birth require supervised care in nutrition as well as regular clinical follow ups with paediatrician.

The parents of an infant are required to be self-aware of infant care and can seek assistance of paediatricians as well as paediatric nutritionists and nursing staff in learning life skills that assist in raising the child with optimum nurturing and utmost care. It takes a lot to raise a child, because without support system, child-rearing is a very difficult task for new parents. Along with family and friends, paediatrician, lactation consultants, child nutritionists, paediatric nurse are very important people to seek advice from in the first two years of child's life.

Infancy is recognized to have observed rapid physical growth as well as cognitive and emotional development. Infants are noticed to have a high nutrient requirement per unit body weight thus requiring attention to detail in nourishment. It is believed that infancy is the phase in life where the foundation of long-term health is laid down. It is this phase of life that unfolds the future of wellbeing of the adult inclusive of physical, cognitive, emotional health.

Growth and Development in Infants

The growth and development in infants is measured under these primary areas:

- Physical Development
- Cognitive Development
- Emotional and Social Development
- Language Development
- Sensory and Motor Development

Physical and Physiological Development

Physical development measures the following:

- Growth

- Increase in Height
- Weight
- Head Circumference
- Muscle Mass
- Fat Mass

Physiological development refers to all the capacities of a human being that accounts for all the biological systems inclusive of muscular skeletal, endocrine, nervous, gastro, cardiovascular, respiratory and reproductive system. The physiological development is discussed around the age classified metabolic, biochemical and hormonal processes in human living bodies. At the birth of a child, newborn screening is performed. This is done within 72 hours of the child's birth in the medical facility of delivery, itself.

In physical examination the pediatrician observes the baby for any congenital deformities as follows:

- Eyes
- Hearing
- Heart
- Hips
- Testicles in Boys

Following are the things that are examined by the pediatrician for baby for any congenital deformities:

- Eyes: Although vision may not be speculated so early but presence of childhood cataract is detected by looking for any clouding in the lens of eyes.
- Heart: The pediatrician uses a stethoscope to hear any heart murmur and rule any congenital heart disease which requires immediate treatment.
- Hips: Few newborns may have a Developmental Dysplasia of the Hip, DDH which may cause a limp and joint problems later. The early investigation allows timely treatment in infant and prevents long run damage.
- Testicles in Boys: In baby boys, at times the testicles may not drop down in to the scrotum until few months after birth. This can be corrected on time if parents are informed and counselled on same.

The newborns physical examination allows parents to acknowledge any congenital deformities and intervene on time. In India, the average birth weight between 2.5 to 2.9 kilograms. It is acknowledged that the birth weight is a prime indicator of the maternal health and nutrition hence a factor in life expectancy of the new-born as well as long term health and development of the child.

Indian pediatrician's categories birth weight as:

- VLBW, i.e., Very Low Birth Weight, where the weight of newborn weighs less than 1.5kg
- ELBW, i.e., Extremely Low Birth Weight, where the weight of newborn weighs less than 1kg.

Possible reasons of low birth weight in infants:

- Child being born with an inherited medical condition.
- A mother giving birth to multiple pregnancies as in twins or triplets.
- Maternal health during pregnancy as in hypertension or gestational diabetes.
- Presence of chronic anemia in the mother during pregnancy.
- Pregnancy associated with HIV/AIDS.
- Mother inflicted to a stress environment, abuse or emotional issues.
- Maternal addiction to alcohol consumption, drugs, or smoking.
- Gestational health with low lying placenta.
- Urinary Tract Infections in the mother.
- Undetermined Preterm labor of the child.
- Nutritional insufficiency of the mother.

Infants born before their due date are **preterm** or **premature and** may or may not have a low birth weight. Babies born on or few days after the due date are **full term**. Babies born 2 or more weeks after their due date are **post mature.** It is recognized that both premature and post mature babies will be at a potential risk of complications and need special post partum care.

Consequences of Low Birth Weight of Newborn Babies

- Difficulty in breastfeeding and latching.
- Respiratory Distress Syndrome (RDS) or breathing problems.
- Risk of infection is increased.
- Reduced blood glucose in infant.

Recommendations to Increase Baby Weight

The neonatal pediatrician advice following to help parents with increasing baby's weight:

- Encourage lactation and complete breastfeeding for 6 months for healthy growth.
- Seeing the doctor for monitoring regular development and growth checks.
- Tracking the baby's height and weight along with nutritional intake every month.
- Staying updated on the immunization schedule.

These are some of the checklists mandatory at a hospital immediately post birth of the baby so that parents are guided accordingly and regular follow up with pediatrician is advised even after discharge from the facility:

- Identifying perinatal asphyxia in delivery room and treatment.
- Identification of high risk newborn following birth as well as before discharge.
- Performing metabolic as well as hearing screening.
- Screening for hyperbilirubinemia.
- Ensuring lactation counseling and encouraging breastfeeding.
- Diagnostic test for hypoglycemia.
- Determining and managing of postnatal hypoxia.

A newborn is checked for all these reflexes by the pediatrician as well as nursing staff. In a baby the involuntary movements or actions are spontaneous and considered normal activity of the baby's reflexes. Some are responses to external stimuli. These reflexes are essentially checked to determine whether the brain and neurosystem of the child is functionally fine.

The reflexes are as follows:

- Rooting Reflex
- Sucking Reflex
- Moro Reflex
- Tonic Neck Reflex
- Grasp Reflex

Rooting Reflex: Rooting reflex is observed in baby from birth till 4 months of age. It allows the child to find breast or nipple to feed. The baby will tilt his head in the direction of stroke or gentle touch and opens mouth as well.

Sucking Reflex: Sucking reflex occurs in concurrence with rooting reflex when child starts to suck for milk / comfort when the roof of the baby's mouth will be gently touched. It is observed that babies born prematurely may have a weak immature sucking ability because the sucking reflex generally appears while in gestation around 32nd week of pregnancy and fully develops around 36th week of term. Babies do have a hand-to-mouth reflex that will go along with the rooting and sucking as children will suck on their fingers or hands.

Moro Reflex: The Moro reflex or the startle reflex is response to a loud sound. The baby reacts with throwing back the head simultaneously extending out arms and legs, crying by curling in the arms and legs back in towards chest. This reflex is observed until the baby is 2 months old and the child is observed to get startled by own crying and triggering the reflex.

NOTES

Tonic Neck Reflex: Tonic neck reflex also called fencing is observed in the baby till 5 to 7 months old. When a baby's head is turned to one side, the arm on that side stretches out and the opposite arm bends up at the elbow.

Grasp Reflex: The child shows grasping with fingers till 6 months and 12 months with toes. Stroking the palm of a baby's hand causes the baby to twirl the fingers in a strong grasp.

Stepping Reflex: Stepping reflex is observed until 2 month of age and is the walking or dance reflex as the baby appears to take steps or dance when held upright by caregiver /parent with the feet touching a solid surface.

Recommended Interventions by Family Members at Home for a New Born Infant

Following are the recommended interventions by family members at home for a new born infant:

- Visual Stimulation
- Auditory Stimulation
- Tactile Stimulation
- Vestibular-Kinesthetic Stimulation
- Carry in Arms

Visual Stimulation: Decorate the child's surroundings with brightly colored objects as well as moving objects. Black and white contrast sends the strongest signals to newborn brain.

Auditory Stimulation: Soft cooing, gentle singing especially by the mother to form bond. It is suggested to also have recorded heart beat and musical toys close to the infant that is not too loud.

Tactile Stimulation: Allowing the newborn to non–nutritive sucking as a comfort. Also gently stroking, flexing, massaging with or without oil or cream helps the babies settle down. Massages mat not be recommended in preterm babies, high-risk birth babies and term babies having asymmetric reflexes or neurologic compromise.

Vestibular-Kinesthetic Stimulation: Rocking, oscillating baby seats that gently sway.

Carry in Arms: Baby should be carried and rocked in arms as it provides proprioceptive sensory input. The proprioceptive system in the muscles and joints of human body. The sense of body awareness and control on force and pressure is offered by the proprioceptive system. This crucially plays a regulatory role in sensory processing subjecting responses to sensory stimuli.

The child health advisors in pediatric care nudge parents to ensure they bring the infant for developmental screening, when the baby is of age:

- 9 Months
- 18 Months

NOTES

- 24 Months
- 36 Months

This is a necessary early intervention for the high risk and developmentally delayed children. The pediatricians may also use Child Behavior CheckList (CBCL) for early pick up of problems like attention deficit. Parents are advised to ask the doctor for school readiness screening before the child is placed in preschool or kindergarten.

Check Your Progress

1. What is infancy? What happens in this phase?
2. How is growth and development in infants measured?
3. List the factors measured in physical development of an infant.
4. What are the different organs that are observed by the pediatrician in physically examining of the baby for any congenital deformities?

1.3 NUTRITIONAL ASSESSMENT

Maternal and newborn health is inter-connected profoundly. While during pregnancy women need wholesome nutrition to meet demands for self as well as the baby, nourishment in the first 1,000 days supports a healthy life for the infant.

Malnutrition in gestation adversely affects the health of both the new born as well as the mother. In India, anemia while pregnancy has always been associated with higher risks of maternal and perinatal mortality. Global data of 2016, indicates an estimated 40% of all pregnant women worldwide were anemic. Globally, annually an estimated 300,000 new born have neural tube defects-spina bifida or anencephaly. The prime cause of anencephaly is deficient folate levels in blood of mother prior to conception and early in the first trimester which can be corrected with supplementation and balanced diet.

15% of all babies worldwide are born with a low birth weight, a primary predictor of poor neonatal health and disability thereby increasing the risk of non-communicable diseases later in life.

Malnutrition in newborn can be avoided by taking care of maternal nutrition which is critical for the health of the gestational mother and baby in womb. During pregnancy it is a priority to supplement:

- Maternal diet with additional Iron and Folic Acid Supplementation (IFAS) in order to reduce the risk of low birth weight, maternal anemia, neural tube defects and preterm birth.
- There is plenty of credible evidence indicating that Multiple Micronutrient Supplementation (MMS) leads to additional improved birth outcomes compared to IFAS.

NOTES

Interventions for newborns increase their chance of survival and have lasting positive effects on their health.

- Early and exclusive breastfeeding helps protect against childhood infections, provides optimal nutrition, supports ideal growth and is associated with reducing the prevalence of overweight, and diabetes later in life.
- Kangaroo Mother Care (KMC) including a continuous skin-to-skin contact with parent or caregiver along with exclusive breastfeeding for 6 months, following up with pediatric care does significantly improve the chance of survival and long-term outcomes for preterm and/or low birth weight babies.

To enhance neonatal health and nutrition, health care providers have to provide birth package care and interventions, which are inclusive of skilled delivery attendant:

- Timely initiation of breastfeeding including colostrum (within one hour of birth).
- Skin to skin contact with mother for all especially for preterm and low birth weight babies.
- Clean umbilical cord care including Chlorhexidine application.
- Optimally-timed cord clamping.
- Maternal nutrition and lactation counseling.

Nutrition Status of Infant

The infant's nutritional status is measured in pediatric health section using anthropometry, observation and taking health history from parents. Following factors are the criteria to measure the nutritional status of an infant:

- Anthropometry
- Weight
- Height or Length
- Pubertal Development
- Head Circumference

Anthropometry

Anthropometry is the measurement of a body that provides useful information about physical growth along with present nutritional condition compared with standard norms. It is an essential consideration that an assessment of nutritional status or growth will not be able to rely on these anthropometric measurements alone. Keeping an account of other factors, such as feeding history, height/length, weight and head circumference are the necessary factors in pediatrics.

NOTES

Weight

Equipment scales available in children's medical center like baby scales, chair or standing scales are calibrated and designed for clinical use. Infants are weighed while in maternity ward and subsequently at least once a week and so forth. The pediatric team decides on the frequency of weighing requires and subsequent adjustment according to clinical condition. Repeat weights should be recorded under similar conditions and at the same time of day as the original measurement.

- To weigh infants and toddlers (up to three years) it is recommended to remove all clothing and weigh them bare.
- For older children weighing is done with minimum of clothing.
- The child's age, size and health condition determines the scale that is to be used.
- To ensure an accurate measurement while weighing a child it should be ascertained that the child is placed centrally and the measurement is recorded when the child is still.
- The weight measurement in India is recorded in kilograms.
- These factors affect the accuracy of measurements of weight, such as intravenous splints or lines, stoma devices present, dressings/drains, timing of bolus/continuous feeds and intravenous therapy.

The measurements of weight are scientifically recorded on a weight chart, observation chart as well as plotted on graphs with the medical notes and in parent-held records.

It is to be acknowledged that:

- A one-time measurement of weight does not hold value in assessing a child's nutritional status.
- Moreover, daily weights are a reflection of body's hydration status rather than nutrition quotient. A measurement of weight fortnightly or monthly is of nutritional importance as reviewed in the light of previous weights and clinical history.
- Children with significant oedema or mass tumors may not be best candidates to assess nutritional status with just measuring weight.
- Weight is then interpreted in conjunction with height/length and age, for which an understanding of the percentile pediatric chart is necessary.

Height or Length

The infant is measured using an equipment used for measuring height or length of different age groups of children:

- The infant is measured using a measuring mat with head and foot boards and a Stadiometer is used for measurement in older children.
- Tape measurement is discouraged in clinical settings.

- Height/length of the infant is measured while in clinic and subsequently at least once a month at pediatric follow-up.
- Infants are measured without clothing and by two nursing staff members or a nurse and parent, using an appropriate measuring mat with head and footboard.
- The infant is placed supinely with the head held against the headboard and gentle downward pressure applied to the knees to ensure that the legs are straight and flat against the mat. Length is then measured by bringing the footboard into contact with the child's heels.
- The standing height of an older child should be measured using an appropriate Stadiometer. Shoes should be removed and the child asked to stand with feet together and heels, buttocks and shoulder blades in contact with the vertical measure.
- Measurement of height/length is inappropriate for children who are unable to stand or bear weight or with conditions that impede correct positioning, for example curvature of the spine. Measurements of length/height should be recorded in centimeters and documented as for weight.

Length/height can provide a useful indication of growth in children. Impaired growth may indicate inadequate feeding, diet or malabsorption, where poor weight gain is also evident. In the presence of adequate weight gain, impaired height may be indicative of metabolic or endocrine disease. Measurements of parental height constitute a useful guide to target height in a child. However, it should be remembered that the parents themselves may not have achieved their full growth potential due to socio-economic factors or illness.

Pubertal development

Pubertal development is accompanied by a period of rapid growth acceleration. Any assessment of growth in adolescence should include evaluation of pubertal staging.

Head Circumference

A thin metal or plastic tape measure is used to measure the head circumference. The pediatric recommendations find it inappropriate to use paper or sewing tape for this purpose.

Monitoring Head Circumference in Children Under Two

Measured and recorded on admission and clinic visits in pediatric ward. The tape is placed on the head of the child so that it lies midway between the eyebrows and hairline at the front of the head and meets with the occipital prominence at the back. To secure the infant safely another nursing staff or caregiver is required to hold the child's head from fidgeting. Measurements of head circumference are recorded in centimeters.

If a child's clinical condition is such that standard anthropometric measurements are inappropriate or misleading for instance, if there is oedema, ascites or solid tumors other techniques are available for measuring growth. The performance of anthropometric measurements provides the nurse with an ideal opportunity to observe the child's general appearance.

With experience a pediatric nurse will be able detect specific signs of poor nutritional status/growth, such as the following:

- Short stature
- Thin arms and legs
- Poor skin condition/skin lesions
- Poor hair condition
- Ascites
- Clearly visible spinal processes or rib cage
- Wasted buttocks
- Oedema, wasted facial appearance, lethargy.

History

A nursing assessment interview conducted on admission is useful information in pertaining to feeding history and parental concerns regarding feeding and growth/ weight gain.

Dietary Record

In order to assess the adequacy of a child's nutritional intake, dietitians require detailed information about all food and drink consumed. As all children admitted to hospital are at risk of nutritional deficit, a dietary record should be started on all in-patients, although this may subsequently be discontinued when deemed appropriate. The dietary record should include details of food and fluids offered and consumed, with quantities expressed in terms of teaspoons, tablespoons and so on. Owing to the difficulties of providing for the likes and dislikes of individual children any record of dietary intake completed during admission is unlikely to provide an ideal reflection of a child's customary intake.

Psychosocial Factors

A number of psychosocial factors may impact on nutritional status, such as family income, family support systems, parenting skills and so on. As with any other aspect of nutritional assessment, psychosocial factors should be interpreted only in the light of other findings.

Nutritional Risk Factors

If any of the following problems are identified during the assessment process the child may he considered to be at increased risk of nutritional deficiency:

- Predisposing Medical Condition
- Static Weight

- Documented Weight Loss
- Perceived Weight Loss
- Poor Intake
- Poor Feeding
- Short Stature
- Pubertal Delay
- Developmental Delay

The short-term implications of failure to address malnutrition in infants will lead to multiple complications in future. This needs to be addressed as early as possible as the long-term implications can be devastating and include stunting, developmental delay and an overall decrease high life expectations of the child while increasing burden of frequent medical aide along with morbidity and mortality.

The issues need to be addressed with understanding, judgment of family's socio-cultural, economic and geographical barriers at all communal level.

The pediatric team of doctor, nurse and nutritionists will have to together work with the parents, kin and caregivers to impart education and awareness to meet nutritional challenges in infancy.

Check Your Progress

5. What does malnutrition in gestation affect?
6. Give the main cause of anencephaly.
7. What are the supplements that are given during pregnancy?
8. How is infant's nutritional status measured in pediatric health?

1.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Infancy is the first year of a human child. An infant is dependent on parents for nourishment and nurturing. As this phase sees a rapid growth in the baby's physical milestones the 1000 days from birth require supervised care in nutrition as well as regular clinical follow ups with paediatrician.
2. The growth and development in infants is measured under these primary areas:
   - Physical Development
   - Cognitive Development
   - Emotional and Social Development
   - Language Development
   - Sensory and Motor Development

3. Physical development measures the following:
    - Growth
    - Increase in Height
    - Weight
    - Head Circumference
    - Muscle Mass
    - Fat Mass
4. In physical examination the pediatrician observes the baby for any congenital deformities as follows:
    - Eyes
    - Hearing
    - Heart
    - Hips
    - Testicles in Boys
5. Malnutrition in gestation adversely affects the health of both the new born as well as the mother.
6. The prime cause of anencephaly is deficient folate levels in blood of mother prior to conception and early in the first trimester which can be corrected with supplementation and balanced diet.
7. During pregnancy it is a priority to supplement:
    - Maternal diet with additional Iron and Folic Acid Supplementation (IFAS) in order to reduce the risk of low birth weight, maternal anemia, neural tube defects and preterm birth.
    - There is plenty of credible evidence indicating that Multiple Micronutrient Supplementation (MMS) leads to additional improved birth outcomes compared to IFAS.
8. The infant's nutritional status is measured in pediatric health section using anthropometry, observation and taking health history from parents.

1.5 SUMMARY

- Infancy is the first year of a human child. An infant is dependent on parents for nourishment and nurturing.
- The parents of an infant are required to be self-aware of infant care and can seek assistance of paediatricians as well as paediatric nutritionists and nursing staff in learning life skills that assist in raising the child with optimum nurturing and utmost care.

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- Infancy is recognized to have an observed rapid physical growth as well as cognitive and emotional development.
- Infants are noticed to have a high nutrient requirement per unit body weight thus requiring attention to detail in nourishment.
- It is believed that infancy is the phase in life where the foundation of long-term health is laid down.
- Physiological development refers to all the capacities of a human being that accounts for all the biological systems inclusive of muscular skeletal, endocrine, nervous, gastro, cardiovascular, respiratory and reproductive system.
- The physiological development is discussed around the age classified metabolic, biochemical and hormonal processes in human living bodies.
- At the birth of a child, newborn screening is performed. This is done within 72 hours of the child's birth in the medical facility of delivery, itself.
- Infants born before their due date are preterm or premature and may or may not have a low birth weight.
- Babies born on or few days after the due date are full term.
- Babies born 2 or more weeks after their due date are post mature.
- In a baby the involuntary movements or actions are spontaneous and considered normal activity of the baby's reflexes.
- Rooting reflex is observed in baby from birth till 4 months of age. It is observed when the corner of one side of baby's mouth is gently.
- Sucking reflex occurs in concurrence with rooting reflex when child starts to suck for milk / comfort when the roof of the baby's mouth will be gently touched.
- Tonic neck reflex also called fencing is observed in the baby till 5 to 7 months old.
- The child shows grasping with fingers till 6 months and 12 months with toes. Stroking the palm of a baby's hand causes the baby to twirl the fingers in a strong grasp.
- Stepping reflex is observed until 2 month of age and is the walking or dance reflex as the baby appears to take steps or dance when held upright by caregiver or parent with the feet touching a solid surface.
- Allowing the newborn to non–nutritive sucking as a comfort. Also gently stroking, flexing, massaging with or without oil or cream helps the babies settle down.
- Massages mat not be recommended in preterm babies, high-risk birth babies and term babies having asymmetric reflexes or neurologic compromise.
- Malnutrition in gestation adversely affects the health of both the new born as well as the mother.

- The prime cause of anencephaly is deficient folate levels in blood of mother prior to conception and early in the first trimester which can be corrected with supplementation and balanced diet.
- Malnutrition in newborn can be avoided by taking care of maternal nutrition which is critical for the health of the gestational mother and baby in womb.
- The infant's nutritional status is measured in pediatric health section using anthropometry, observation and taking health history from parents.
- Anthropometry is the measurement of a body that provides useful information about physical growth along with present nutritional condition compared with standard norms.
- Pubertal development is accompanied by a period of rapid growth acceleration. Any assessment of growth in adolescence should include evaluation of pubertal staging.
- A number of psychosocial factors may impact on nutritional status, such as family income, family support systems, parenting skills and so on.
- The short-term implications of failure to address malnutrition in infants will lead to multiple complications in future.

1.6 KEY WORDS

- **Infancy**: Infancy is the first year of a human child.
- **Physiological development**: Physiological development refers to all the capacities of a human being that accounts for all the biological systems inclusive of muscular skeletal, endocrine, nervous, gastro, cardiovascular, respiratory and reproductive system.
- **Full term**: Babies born on or few days after the due date are full term.
- **Post mature**: Babies born 2 or more weeks after their due date are post mature.
- **Anthropometry**: Anthropometry is the measurement of a body that provides useful information about physical growth along with present nutritional condition compared with standard norms.

1.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. Define infancy. What happens in this phase?
2. What are the requirements of a baby during infancy period?
3. What does physiological development of an infant mean?

4. Expand the terms VLBW and ELBW. What is the weight of an infant in them?
5. List the possible reasons of low birth weight in infants.
6. How is head circumference in children under two years of age monitored?

Long-Answer Questions

1. Discuss the consequences of low birth weight of newborn babies?
2. Explain in detail the recommendations to increase the weight of baby.
3. Distinguish between rooting reflex and sucking reflex and explain them.
4. Describe the recommended interventions by family members at home for a new born infant.
5. Give a detailed overview of nutritional assessment in infants.
6. Explain the factors to measure the nutritional status of an infant.
7. Analyse the nutritional risk factors in an infant and explain them.

1.8 FURTHER READINGS

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UNIT 2 ANTHROPOMETRIC MEASUREMENTS AND BIOCHEMICAL PARAMETERS

Structure

2.0 Introduction
2.1 Objectives
2.2 Anthropometric Measurements, Biochemical Parameters, Clinical and Dietary Data of Infants
  2.2.1 Anthropometric Measurements
  2.2.2 Biochemical Parameters
  2.2.3 Clinical Data of Infants
  2.2.4 Dietary Data of Infants
2.3 Answers to Check Your Progress Questions
2.4 Summary
2.5 Key Words
2.6 Self Assessment Questions and Exercises
2.7 Further Readings

2.0 INTRODUCTION

Anthropometric measurements are a series of quantitative measurements of the muscle, bone, and adipose tissue used to assess the composition of the body. The core elements of anthropometry are height, weight, Body Mass Index (BMI), body circumferences and skinfold thickness. These measurements are important because they represent diagnostic criteria for obesity, which significantly increases the risk for conditions, such as cardiovascular disease, hypertension, diabetes mellitus, and many more. There is further utility as a measure of nutritional status in children and pregnant women. Additionally, anthropometric measurements can be used as a baseline for physical fitness and to measure the progress of fitness.

Biochemical parameters represent better, precise, and objective tools toward the assessment of the nutritional status of children in comparison to anthropometric, clinical, and dietary methods. They constitute laboratory tests to estimate the concentration of circulating nutrients in body fluids. Biochemical parameters are suggestive of acute or subclinical conditions when other methods of nutritional assessment fail to interpret the condition. These parameters exhibit substantial variability in their reproducibility. Moreover, these parameters are novel tools in the hands of clinicians for screening of the nutritional status of children.

Good nutrition is essential for the growth and development that occurs during an infant's first year of life. When developing infants are fed the appropriate types and amounts of foods, their health is promoted. Positive and supportive feeding attitudes and techniques demonstrated by the caregiver help infants develop healthy attitudes toward foods, themselves, and others. To determine an infant's nutritional needs and develop a nutrition care plan, an accurate assessment of the infant's nutritional status must be performed. The nutrition assessment provides the nutritionist or health counselor with important feeding practices and other information pertinent to an infant's health. Nutrition education sessions can then be designed to encourage positive, appropriate feeding practices and, if necessary, recommend strategies to correct inappropriate practices. By communicating periodically with a caregiver about an infant's nutritional needs in the first year of life, better care for the infant is assured.

In this unit, you will study about anthropometric measurements, biochemical parameters, clinical and dietary data of infants.

2.1 OBJECTIVES

After going through this unit, you will be able to:

- Understand anthropometric measurements
- Discuss biochemical parameters
- Explain clinical and dietary data of infants

2.2 ANTHROPOMETRIC MEASUREMENTS, BIOCHEMICAL PARAMETERS, CLINICAL AND DIETARY DATA OF INFANTS

To ensure the child is growing as per required milestones assessments are undertaken in the pediatric clinic. The child is measured through invasive as well as non-invasive measurements to chart normal growth and nutritional status.

The five modes of collecting data on child's growth and analyzing the results are:

- Anthropometric Measurements
- Biochemical Parameters
- Clinical Investigations
- Dietary Data

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2.2.1 Anthropometric Measurements

Anthropometric measurements are quantitative that are taken in an infant of the muscle, bone and fat mass or adipose tissue. This is the first parameter of investigation used to assess the composition of the human body, child or adult.

The primary elements of anthropometry are:

- Height or Length
- Weight
- Body Mass Index (BMI)
- Body Circumferences (Waist, Hip, and Limbs)
- Skin Fold Thickness

These measurements are important in pediatric centers as they indicate growth children mellitus. The anthropometric information is utilized to measure of nutritional status in children and pregnant women.

Indicators for Anthropometric Measurements in Infants

The possible indicators for anthropometric measurements in infants include:

- Stunting
- Wasting
- Low BMI

Stunting: Stunting is when can infant will have a low height-for-age.

Wasting: Wasting is when an infant will have a low weight-for-height.

Underweight: Underweight infant will have a low weight-for-age.

Anthropometric Measurements Used in Infants to Mark Indicator:

- Mid-Upper Arm Circumference (MUAC) is a viable measurement in infants as a marker of nutritional status. Mid upper arm circumference measurement of 11cms can be used as a cut-off for Severe Acute Malnourished (SAM) identified infants in the age group under 6 months of age. It is to be noted that the measurements of MUAC is not gender specific. Moreover, weight and MUAC are significantly lower infants with severe acute malnutrition although there is no difference in the length but the weight and MUAC both are affected but length if the infant may not incase of SAM.
- Body Mass Index (BMI) is an index of nutritional status and is a measurement of malnutrition in children and adults. Low BMI indicates under nutrition whereas high BMI range also indicates malnutrition due to obesity and the severity of obesity.

Drawback of Anthropometric Measurement:

The drawback of anthropometric measurement is the present physiological condition in the infant for instance the presentation of clinical chronic ailment,

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hospitalization or physical limitations like a fracture cast may be barrier to accurate readings.

Resources Required:

1. Equipment
    - Weight Scale
    - Calibration Weights
    - Box to Sit On
    - Stadiometer
    - Knee Caliper
    - Skinfold Calipers
    - Tape Measure
    - Infantometer to Measure Recumbent Length
2. Graphs to Plot / Cut-Off / Checklists to Compare- From WHO or Indian Pediatrics
3. Pencil and Eraser

Standard Protocols to Take Anthropometric Measurements in Infants

- Weight measurement is taken in kilograms in India. As infants are unable to stand alone on the scale on two feet, it is important that first a parent/nurse stands on the weighing scale and zero the scale with the adult standing on the scale. The infant is then taken in arms of the parent/nurse standing on scale to obtain a weight of the child.
- When measuring height of the infant, the child who is able to stand should be able to with his or her heels together and weight evenly distributed.
- The infant should be positioned with the shoulder blades, buttocks as well as heels placed on the Stadiometer's vertical backboard. If not able to have all three points of contact on the vertical backboard, the heels and buttocks must touch the vertical backboard.
- The infant standing on feet should be tried to face them outward at a 60 degree angle. The horizontal bar of the Stadiometer should be lowered until the hair is compressed to the crown of the head. Remove any objects on the head or hair that obstruct the bar from compressing the hair to the level of the crown of the head.
- For infants to measure the head circumference place the tape measure above the eyebrows, above the ears, and over the occipital prominence. For a snug fit do tighten the measuring tape.
- As there are different skin fold sites available for measurement that include the biceps, triceps, iliac crest, thigh, calf, sub scapular, abdomen, and chest. The technique may vary for each, but let us discuss one method which is the

triceps skin fold. Pinch the skin 2 cm above the midpoint of the right upper arm with the thumb and index finger that will create a skin fold and accordingly place the calipers at the midpoint. The rest of the common sites can be measured similarly by pinching of the skin 2 cm away from the site to be measured.

- To calculate the BMI: Calculation is the weight in kilograms, divided by the height in meters squared.

Use of graphs and charts help measure percentile of growth and World Health Organisation (WHO) standard graphs are most commonly used. Indian Pediatric standards can also be referred too for latest guidelines used by pediatricians in the country.

Drawback of Anthropometric:

The drawback of anthropometric measurement is an error in taking measurements of weight and height/length and obtaining measurements in a non-uniform manner in infants as they fidget more and can be cranky as well at time of measurements.

Benefit of Anthropometric:

Anthropometric measurements are extensively used in the pediatric population to determine nutritional status with the measurements of the height for age, weight for age, and weight for height and comparing with universal standards of WHO, it can be determined if the infant is in risk of being stunted, underweight, or wasting of growth. If these conditions are confirmed, the pediatrician considers replacing nutrients, secondary causes of the condition, and a potential referral to a pediatric dietitian. Head circumference which is an anthropometric measurement routinely used in children is important to diagnose microcephaly in children. The anthropometric measurement useful to assess nutritional status in infants and pregnant women is Mid-Upper Arm Circumference (MUAC), which can be used to define the severity of malnutrition.

2.2.2 Biochemical Parameters

Physiologic and Biochemical Changes in Infants: Understanding the clinical chemistry including biochemistry, medicine as well as technology for pediatric sections- newborns and infants involves the need to recognize that blood collection from a small infant, working with small specimen volumes that require specific procedures ideally customized for children. Understanding biochemical investigations and parameters for infants is necessary to require appropriate age-related reference ranges be used to evaluate laboratory results.

An infant's body will foresee physiologic changes in the water and fat content in the very first few hours and days post birth. A newborn infant has a 70% to 75% of body weight as water content compared with 50% to 55% in adults. The 40 % of this water content is present in the extracellular fluid and a reduction of body weight in the first weeks since birth due to contraction of the extracellular fluid space.

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- The pediatric ward will observe a 5% to 10% weight reduction in infants born full term whereas an observational weight loss of 10% to 20% in preterm infants where the total body water content is high in proportion to total body weight.
- Some biochemical markers of the infant are similar to the mother at birth.
- The calcium increases with gestational age and is higher at birth than paired maternal values. Post delivery, plasma calcium falls, reaching its lowest concentration 24 to 48 hours after birth. The decrease in calcium results in an increase in parathyroid hormone and mobilization of calcium from bone, resulting in an increase in plasma calcium concentration.
- Ionized calcium, which is the active calcium, is monitored frequently in infants as a more direct evaluation of calcium status.
- Phosphorus concentrations and alkaline phosphatase activity will be slightly higher than the mother's due to placental effects.
- Except for Immunoglobulin G (IgG), plasma proteins do not cross the placenta and therefore reflect intrauterine nutrition and maturity.
- Laboratory test results reflect the physiologic differences between the premature and mature infant. Premature infants have less mature enzyme systems, less protein binding, hyperbilirubinemia, and immature renal function. For example, the glomerular filtration rate increases with increasing gestational age. In the premature infant, the postnatal fall in creatinine concentration (which occurs over several days in the infant born at term) is prolonged and may not reflect the glomerular filtration rate or renal status.

2.2.3 Clinical Data of Infants

Specimen for an infant: In newborn babies and infants the blood samples is obtained by pricking the finger or heel puncture which is the capillary sample by peripheral vessel. Incase there is a need to draw the blood sample with indwelling catheter it is considered arterial blood. Blood obtained from skin puncture contains blood from arterioles, venules, and capillaries. In addition, varying degrees of contamination from interstitial and intracellular fluids are present.

As a pediatric health care provider the effort is to minimize blood collection in infants. Malnourished or very unwell infants may require transfusions after blood draws. Transfusion becomes essential when more than 10% of blood volume is drawn over several days for instance 8 ml of blood drawn from a 750 g infant. It is important to know that frail veins must be saved for parenteral nutrition in infants who are very unwell.

To avoid blood loss the phlebotomists, nurses, and physicians are trained with to draw blood from newborns informed on the volume of blood required for

particular diagnostic test or series of tests. Excessive blood loss is discouraged and phlebotomist should carefully monitor volumes in infants who are extremely unwell with low-birth-weight infants.

Hospital borne infections are prevented while performing skin punctures and proper infection control procedures include thorough hand washing and gloving, and the use of 75% isopropanol to cleanse the puncture site. The site should be warmed before pricking to increase blood flow. The most preferred and optimal site in infants for pricking is the heel. Urine is collected in infants by catheterization when required by pediatrician.

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Factors Affecting Diagnostic Test Results

In Infants, presence of:

- Hemolysis
- Lipemia
- Bilirubin

May interfere with the results of the tests.

Newborn Screening

Newborn screening is a series of blood tests to rule out certain endocrine and genetic disorders. Newborn screenings are potent to identify risk of childhood diseases before the onset of clinical symptoms. Early detection and intervention prevents chronic stage illness and disabilities. The list of conditions for which newborn and infant screening is carried out varies according to each country's public health policies which are created on the prevalence of the condition and available resources.

Though universal screening is a cost-intensive exercise, the universal screening for about 40 to 50 metabolic disorders is mandatory in US, Europe and many other countries across the world. The benefit of early screening exceeds the cost as it helps in reducing the mortality and morbidity of these diseases.

The conditions for which neonatal screening has been proposed in Indian scenario include:

- Hearing Loss
- Congenital Hypothyroidism
- Congenital Adrenal Hyperplasia (CAH)
- Glucose-6-Phosphate Dehydrogenase (G6PD) Deficiency

Considering the prevalence of these conditions and huge financial implications for universal screening for a developing country like India, a practical approach categories the conditions as follows:

Category A (All Newborns): Screening for congenital hypothyroidism and hearing is must in Indian scenario. Screening for CAH, i.e., Congenital Adrenal

NOTES

Hyperplasia and G6PD, i.e., Glucose-6-Phosphate Dehydrogenase deficiency may be added in a phased manner. G6PD screening should be done in Northern states of the country. Screening for Sickle cell disease and other hemoglobinopathies should be undertaken in pockets of high incidence.

Category B (High Risk Screening): Screening for the following disorders should be conducted in the high risk population (consanguinity, previous children with unexplained intellectual disability, seizure disorder, previous unexplained sibling deaths, critically ill neonates, newborns/children with symptoms/ signs/ investigations suggestive of inborn errors of metabolism). These conditions include phenylketonuria, homocystinuria, alkaptonuria, galactosemia, sickle cell anemia and other hemoglobinopathies, cystic fibrosis, biotinidase deficiency, maple syrup urine disease, medium-chain acyl-CoA dehydrogenase deficiency, tyrosinemia and fatty acid oxidation defects.

Category C: Screening (in resource-rich setting/expanded screening) for 30-40 inherited metabolic disorders may be offered to 'well-to-do' families, especially in urban settings where facilities for sending sample to laboratory are available.

India is going through a progressive transitional phase of control over infant mortality and morbidity due to infections, and emergence of genetic conditions. The WHO has recommended that genetic services should be introduced in countries with an Infant Mortality Rate (IMR) less than 50. India with an IMR of 40 should introduce newborn screening and genetic services. The Indian Academy of Pediatrics strongly advocates inclusion of newborn screening in our public health policy, and will offer its technical and logistic inputs to the Government of India for initiating this program.

Preliminary Investigations in Neonates

Jaundice is the most common reason, aside from screening and prophylaxis, for testing and treatment of newborn infants. Jaundice usually appears about 3 days after birth and disappears by second week due to hyperbilirubinaemia. As the liver in neonate has yet to reach potential it is overwhelmed by rapid break down of Red Blood Cells (RBC's) and processing the bilirubin causing jaundice in babies.

There could be other possible reasons for pathological jaundice in neonates:

- Underactive Thyroid Gland - Hypothyroidism.
- Incompatible Blood Group - The mother and baby have different blood types.
- Rhesus Factor Disease - Mother has rhesus-negative blood and the baby has rhesus-positive blood.
- Urinary Tract Infection (UTI).
- Crigler-Najjar Syndrome- Inherited deficit in enzyme responsible for processing bilirubin.

- Blockage in bile ducts and gallbladder.
- Inherited enzyme deficiency of Glucose-6-Phosphate Dehydrogenase (G6PD)

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Hypoglycemia is detected in new born babies to check for very low blood glucose levels which could be possibly due to poor nutrition for the mother during pregnancy, gestational diabetes in mother, incompatible blood types of mother and baby causing severe hemolytic disease of the newborn, birth defect, liver disease, infection. A simple blood test for blood glucose levels can diagnose the problem.

2.2.4 Dietary Data of Infants

To determine an infant's nutritional needs and develop a nutrition care plan, an accurate assessment of the infant's nutritional status must be performed. The nutrition assessment provides the nutritionist or health counselor with important feeding practices and other information pertinent to an infant's health. The assessment should include an examination of:

Health and Medical Information

Information gathered through chart review, caregiver interview, health care provider referral form(s), or other sources that may include history of chronic or acute illnesses or medical conditions, birth history, developmental disabilities, a clinical assessment identifying signs of nutritional deficiencies, and other pertinent information, for example immunization record.

Dietary Intake Data

Feeding history – Eating behaviour, feeding techniques, feeding problems, and environment.

- **Appetite and Intake:** Usual appetite, factors affecting intake, such as preferences, allergies, intolerances, chewing/swallowing problems, feeding skills.
- **Diet History:** Breastfed or infant formula-fed; frequency and duration of breastfeeding; frequency and amount of infant formula or complementary foods fed; age at introduction of complementary foods; variety of complementary foods provided; vitamin/mineral or other supplements given; and problems, such as vomiting, diarrhea, constipation, or colic.
- **Socioeconomic Background:** Primary and other caregivers, food preparation and storage facilities, use of supplemental feeding and financial assistance programs, access to health care, and ethnic and/or cultural influences on the diet.

Anthropometric Data

Anthropometric measurements, i.e., weight for age, length for age, weight for length, and head circumference for age;

Biochemical Data

Data used to diagnose or confirm nutritional deficiencies or excesses; in the Women, Infants, and Children (WIC) Program, hemoglobin, hematocrit, or other hematological tests are performed to screen for iron deficiency anemia.

Check Your Progress

1. List the modes of collecting data and analyzing the results on child's growth.
2. What is anthropometric measurement?
3. Name the primary elements of anthropometry.
4. What is BMI? What does low BMI indicated?
5. Give the drawback of anthropometric measurement.
6. Why is transfusion important?
7. How is urine collected in infants?
8. Define newborn screening.
9. List the conditions for which neonatal screening is proposed in Indian scenario.
10. How is hypoglycemia detected in infants?

2.3 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. The five modes of collecting data on child's growth and analyzing the results are:
    - Anthropometric Measurements
    - Biochemical Parameters
    - Clinical Investigations
    - Dietary Data
2. Anthropometric measurements are quantitative that are taken in an infant of the muscle, bone and fat mass or adipose tissue. This is the first parameter of investigation used to assess the composition of the human body, child or adult.
3. The primary elements of anthropometry are:
    - Height or Length
    - Weight
    - Body Mass Index (BMI)
    - Body Circumferences (Waist, Hip, and Limbs)
    - Skin Fold Thickness

NOTES

4. Body Mass Index (BMI) is an index of nutritional status and is a measurement of malnutrition in children and adults. Low BMI indicates under nutrition whereas high BMI range also indicates malnutrition due to obesity and the severity of obesity.
5. The drawback of anthropometric measurement is the present physiological condition in the infant for instance the presentation of clinical chronic ailment, hospitalization or physical limitations like a fracture cast may be barrier to accurate readings.
6. Transfusion becomes essential when more than 10% of blood volume is drawn over several days for instance 8 ml of blood drawn from a 750 g infant.
7. Urine is collected in infants by catheterization when required by pediatrician.
8. Newborn screening is a series of blood tests to rule out certain endocrine and genetic disorders.
9. The conditions for which neonatal screening is proposed in Indian scenario include:
   - Hearing Loss
   - Congenital Hypothyroidism
   - Congenital Adrenal Hyperplasia (CAH)
   - Glucose-6-Phosphate Dehydrogenase (G6PD) Deficiency
10. Hypoglycemia is detected in new born babies to check for very low blood glucose levels which could be possibly due to poor nutrition for the mother during pregnancy, gestational diabetes in mother, incompatible blood types of mother and baby causing severe hemolytic disease of the newborn, birth defect, liver disease, infection.

2.4 SUMMARY

- To ensure the child is growing as per required milestones assessments are undertaken in the pediatric clinic.
- The child is measured through invasive as well as non-invasive measurements to chart normal growth and nutritional status.
- Anthropometric measurements are quantitative that are taken in an infant of the muscle, bone and fat mass or adipose tissue.
- The anthropometric information is utilized to measure of nutritional status in children and pregnant women.
- Stunting is when can infant will have a low height-for-age.
- Underweight infant will have a low weight-for-age.

- Mid-Upper Arm Circumference (MUAC) is a viable measurement in infants as a marker of nutritional status.
- Mid Upper Arm Circumference (MUAC) measurement of 11cms can be used as a cut-off for Severe Acute Malnourished (SAM) identified infants in the age group under 6 months of age.
- Body Mass Index (BMI) is an index of nutritional status and is a measurement of malnutrition in children and adults.
- Low BMI indicates under nutrition whereas high BMI range also indicates malnutrition due to obesity and the severity of obesity.
- The drawback of anthropometric measurement is the present physiological condition in the infant for instance the presentation of clinical chronic ailment, hospitalization or physical limitations like a fracture cast may be barrier to accurate readings.
- Weight measurement is taken in kilograms in India. As infants are unable to stand alone on the scale on two feet, it is important that first a parent/nurse stands on the weighing scale and zero the scale with the adult standing on the scale.
- When measuring height of the infant, the child who is able to stand should be able to with his or her heels together and weight evenly distributed.
- For infants to measure the head circumference place the tape measure above the eyebrows, above the ears, and over the occipital prominence.
- The drawback of anthropometric measurement is an error in taking measurements of weight and height/length and obtaining measurements in a non-uniform manner in infants as they fidget more and can be cranky as well at time of measurements.
- Anthropometric measurements are extensively used in the pediatric population to determine nutritional status with the measurements of the height for age, weight for age, and weight for height and comparing with universal standards of WHO, it can be determined if the infant is in risk of being stunted, underweight, or wasting of growth.
- The anthropometric measurement useful to assess nutritional status in infants and pregnant women is Mid-Upper Arm Circumference (MUAC), which can be used to define the severity of malnutrition.
- Some biochemical markers of the infant are similar to the mother at birth.
- The calcium increases with gestational age and is higher at birth than paired maternal values.
- Post-delivery, plasma calcium falls, reaching its lowest concentration 24 to 48 hours after birth.
- The decrease in calcium results in an increase in parathyroid hormone and mobilization of calcium from bone, resulting in an increase in plasma calcium concentration.

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- Ionized calcium, which is the active calcium, is monitored frequently in infants as a more direct evaluation of calcium status.
- Phosphorus concentrations and alkaline phosphatase activity will be slightly higher than the mother's due to placental effects.
- In newborn babies and infants the blood samples is obtained by pricking the finger or heel puncture which is the capillary sample by peripheral vessel.
- Newborn screening is a series of blood tests to rule out certain endocrine and genetic disorders.
- Newborn screenings are potent to identify risk of childhood diseases before the onset of clinical symptoms.
- Jaundice is the most common reason, aside from screening and prophylaxis, for testing and treatment of newborn infants.
- Hypoglycemia is detected in new born babies to check for very low blood glucose levels which could be possibly due to poor nutrition for the mother during pregnancy, gestational diabetes in mother, incompatible blood types of mother and baby causing severe hemolytic disease of the newborn, birth defect, liver disease, infection

2.5 KEY WORDS

- **Stunting:** Stunting is when can infant will have a low height-for-age.
- **Wasting:** Wasting is when an infant will have a low weight-for-height.
- **Underweight:** Underweight infant will have a low weight-for-age.
- **Mid-Upper Arm Circumference (MUAC):** Mid-Upper Arm Circumference (MUAC) is a viable measurement in infants as a marker of nutritional status.
- **Body Mass Index (BMI)**: Body Mass Index (BMI) is an index of nutritional status and is a measurement of malnutrition in children and adults.
- **Newborn screening**: Newborn screening is a series of blood tests to rule out certain endocrine and genetic disorders.

2.6 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. Distinguish between anthropometric measurements and biochemical parameters.
2. How anthropometric measurement is indicated in infants?
3. Expand the term MUAC. What is MUAC?

4. Give the benefits of anthropometric measurements.
5. How is specimen collected of an infant?
6. What are the factors that affect the diagnosis of test result?
7. Give some possible reasons for pathological jaundice in neonates.
8. Write a short note on dietary data of infants.

Long-Answer Questions

1. Explain anthropometric measurements in detail.
2. Analyse the biochemical parameters of infants.
3. Explain the clinical data of infants.
4. Describe newborn screening in detail.
5. Discuss the dietary data of infants.

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UNIT 3 NUTRITIONAL AND FOOD REQUIREMENTS FOR INFANTS

NOTES

Structure

3.0 Introduction
3.1 Objectives
3.2 Nutritional and Food Requirements for Infants
3.3 Answers to Check Your Progress Questions
3.4 Summary
3.5 Key Words
3.6 Self Assessment Questions and Exercises
3.7 Further Readings

3.0 INTRODUCTION

Infant nutrition is the description of the dietary needs of infants. A diet lacking essential calories, minerals, vitamins, or fluids is considered inadequate. Breast milk provides the best nutrition for these vital first months of growth when compared to infant formula. For example, breastfeeding aids in preventing anemia, obesity, and sudden infant death syndrome; and it promotes digestive health, immunity, intelligence, and dental development. Infants are usually not introduced to solid foods until four to six months of age. Good nutrition is essential for the growth and development that occurs during an infant's first year of life. When developing infants are fed the appropriate types and amounts of foods, their health is promoted. Positive and supportive feeding attitudes and techniques demonstrated by the caregiver help infants develop healthy attitudes toward foods, themselves, and others.

The needs of infants determine the amount of nutrition required to maintain and support adequate growth and optimal health while maintaining homeostasis with other nutrients. Nutritional requirements vary in infancy, and growth patterns are closely linked to optimized nutrition. The use of standardized definitions is essential when plotting growth in infancy. Energy expenditure for basal metabolic processes, regular physical activities, as well as unexpected increased energy utilization for pathological conditions, determine the infant's caloric intake. A healthy child from birth to 1 year should receive around 100 kcal/kg/day. Neonatal caloric requirements are higher at about 110–135 kcal/kg/day.

In this unit, you will study about nutritional and food requirements for infants.

3.1 OBJECTIVES

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After going through this unit, you will be able to:

- Discuss nutritional requirements for infants
- Analyse food requirements for infants

3.2 NUTRITIONAL AND FOOD REQUIREMENTS FOR INFANTS

The initial 24 months in every infant's life is pivotal to lay the foundation for optimal growth and development. Infant from birth to two years of age essentially require a diet that will meet the nutritional requirement for acceleration in the normal physical and mental growth. Every month after weaning from lactation, the diet is modified by adjusting to the requirements of energy, protein, vitamins, and iron along with calcium. An infant has a stomach which is small, comparable to size of its own two fists together and has limited capacity to ingest as compared to an adult. So, an infant cannot consume much at one meal hence it is pivotal to prepare a meal that provides both micro nutrients including vitamins all minerals and macro nutrients inclusive of carbohydrates, protein and fat.

The primary 180 days of life an infant requires exclusive breast feeding which is the best food for the baby. Nutrition in optimal amount is required for the growing infant needs.

Lactation describes the secretion of milk from the mammary glands and the period of time that a mother lactates to feed her young. The lactation is provided on-demand and done frequently. Exclusive breast feeding meets all nutritional requirements of the infant for 6 months. Water is also not required in initial 6 months as the foremilk which is the milk at the beginning of feed has more water as compared to the hind milk which is last feed of the breast feeding.

While for the first six months a baby should only be fed breast milk, post that complementary feeding should be initiated without weaning the baby off breast milk. Breastfeeding has to be continued for two years and beyond; after six months it needs to be complemented with adequate, safe and proper food and liquid to meet the additional nutrition needs of the young growing infant.

Complementary feeding is defined as giving infants food and liquid in addition to formula and/or breast milk, when breast milk and/or formula alone no longer meet the nutritional requirements of the infant. Complementary feeding begins in infants after they complete 6 months of age and it is emphasizes repeatedly to be adequate, safe and proper.

Emphasis is on the first 1000 days of life to create the groundwork for growth and development of children.

The leading institutions World Health Organization (WHO) as well as United Nations International Children's Emergency Fund (UNICEF) have given prominence on this health shaping duration of 270 days in the womb and first 1000 days after birth as an optimal period for adequate physical, mental, and cognitive growth along with milestone development of the children. It is necessary to provide appropriate guidelines and guidance to the pediatric health care providers and care givers to improve the survival of infants and young children in India. The timely interventions decrease considerable morbidity and mortality at this age but also empower a healthy family and community, thereby paving the way for the future economic development of the country.

First Food of a Baby

According to the WHO global acknowledgement is given to colostrum as the perfect food for every newborn.

Colostrum is the thick consistency, yellowish substance produced by the mother immediately after delivery and it last for first 2 to 4 days of child birth.

Colostrum

- It is rich in lactalbumin, lactoprotein.
- The colostrum is known to provide Immunoglobulins (Igs), such as IgA, IgG, IgG2, IgM antibodies.
- It has antimicrobial peptides, such as lactoferrin and lactoperoxidase.
- The colostrum will provide growth factors to the infant, such as epidermal growth factor, Transforming Growth Factor-α (TGF-alpha), TGβ, insulin-like growth factor, and vascular endothelial growth factors to the infant.
- Providing growth hormone which not only provides immunity but also fosters the growth and development of the newborn.
- Offering colostrum is an essential component of post natal primary child nutrition.

In a maternity ward the health care workers offer immediate skin-to-skin contact of the mother and baby after the birth that keeps the new born appropriately warm, inducing the release of maternal oxytocin ensuring that the child receives colostrum during the first feeds. The contents of the colostrums inclusive of the growth factors and Vitamin A aid in the infant's intestine to mature and stimulate bowel movement to essential pass and clear away meconium and reduce chances of any infection.

Barrier in offering colostrum feeding to the newborn are as follows:

- There is lack of awareness, barrier due to cultural factors and hence the introduction of prelacteal feeding to new born may be delayed along with initiation of breastfeeding.

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- At times maternal illness or a cesarean section is found to be a common barrier to colostrum feeding. India has some taboos that colostrum is curdled/cursed milk or a bad omen creates delays in breastfeeding for about 3 days until the mother is supposedly pure after a ritual bath, when colostrum is discarded and buried to protect the mother from evil eyes.
- Prelacteal feeds known as the ghutti is the undiluted milk, sacred water, or honey given on the first day of birth that prevents the mothers from giving colostrum.
- The feeding and rearing practices of children, especially infants in developing countries, are rooted in cultural beliefs. Therefore, good communication and awareness are required to educate and eradicate these interferences of cultural practices.

Exclusive Breastfeeding

Exclusive breastfeeding is defined as the practice of giving only breast milk for the first 6 months of life (no other foods or water). Exclusive breastfeeding meets all the nutritional needs of infants if the breastfeeding technique is followed appropriately. It is an integral part of optimal infant and young child feeding practice, which also includes the early initiation of breastfeeding within 1 hour of birth and continued breastfeeding for up to 2 years.

The WHO expert committee strongly claims and preaches that an infant who was exclusively breastfed for 6 months has a reduced risk of developing:

- Atopic Dermatitis
- Acute Otitis Media
- Gastrointestinal Infections
- Lower Respiratory Tract Infections
- Asthma
- Cognitive Impairment
- Cardiovascular Diseases
- Diabetes Mellitus

The importance of exclusive breastfeeding is that it helps to drive global nutritional target diseases, such as stunting, anemia in the reproductive age group, low birth weight, childhood overweight, and wasting. Breastfeeding continued beyond 1 year of age provides essential fatty acids which are mostly not supplemented by complementary foods but essential for pre-carotenoid synthesis for Vitamin A.

Advantages to mothers who exclusively breastfeed their infants include regaining their pre-pregnancy weight and delayed conception.

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Hindrances to exclusive breast feeding in India are as follows:

- Women going to work.
- Lack of awareness on exclusive breastfeeding.
- Inappropriate breastfeeding techniques- difficulty in latching the baby.
- Hospital practices not encouraging as per breastfeeding policies.
- Lack of skilled nurses or lactation consultants.
- Excessive marketing and promotion of infant formula feeding and the lack of legislation in support of breastfeeding policies.

Exclusive breast feeding for 6 months require strong awareness campaign at every community-level commitment involving family members, community health workers, and communication channels. In India, the strategies adopted are communication channels, peer to peer or group counseling, and behavioral change communications through mass-media campaigns to promote exclusive breastfeeding.

Capacity building of community health workers on breastfeeding through Mothers Absolute Affection is the appraising initiative taken by India for the promotion and support of breastfeeding at the community level. The program is implemented by health workers at the root level through mothers meetings, lactation support, and interpersonal communications. A pioneer encourage of breast feeding campaign is Tamil Nadu, the state of India in introducing air-conditioned breastfeeding rooms in public places to aid nursing mothers.

Experiences indicate that advocating 10 steps of Baby Friendly Hospital Initiative (BFHI) are visibly successful in encouraging proper infant feeding practices starting at birth. It is necessary to set standards in antenatal care, immunization clinics, and sick baby clinic to monitor appropriate infant feeding for up to 2 years. In-service training of health-care workers, frontline workers, and supervisions is also essential in strengthening breastfeeding at health institutions and the community level.

Sensitization by Health-Care Providers before Discharge from Hospital

The breastfeeding process is initiated from the maternity station at the hospital where the message conveyed to the mother should be appropriate and acceptable. There should be needful sensitization of health-care workers of hospital and community such as Auxiliary Nurse Midwife, Accredited Social Health Activist, Anganwadi workers, nurses, and doctors for lactation support and management at the facilities. In India, the lactation education should not focus only on nursing mothers but also directed at family members and village leaders who are the decision-makers in infant feeding.

The strategies should focus on linking older women groups or traditional birth attendant-dais to BFHI. Since practicing exclusive breastfeeding for 6 months

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is a daily and long-term challenge, various strategies should be used to sustain encouragement at the household and community levels.

Improving Awareness through World Breastfeeding Week (WBW) which is celebrated every year from 1 to 7 August by the WHO, UNICEF, World Alliance for Breastfeeding Alliance (WABA), and government policymakers to protect, promote, support breastfeeding and join hands with health centers and hospitals to encourage all mothers to adopt appropriate breastfeeding practices. Interactive sessions with mothers, sensitization programs for undergraduates and postgraduates on breastfeeding, symposiums, exhibitions, and outreach programs on breastfeeding all over India to emphasize the importance of breastfeeding take place and make a huge impact on lactation promotion campaign.

Complementary Feeding

In addition to breastfeeding, to meet the nutritional needs of the infant, complementary foods are added to the diet of the child. The transition from exclusive breastfeeding to family foods, referred to as complementary feeding, typically covers the period from 6 to 24 months of age, which is considered a very vulnerable period prone to malnutrition. Apart from energy requirement, certain micronutrients, such as Iron, Zinc, and Vitamin A which are reduced in breastfeeding before 6 months should be supplemented in complementary feeding. Timely introduction of complementary feeding at 6–8 months is crucial. Early weaning leads to an increased risk of type 1 diabetes, obesity, celiac disease, and eczema, and late weaning after 8 months leads to deficiency of zinc, protein, iron, and Vitamins B and D.

Nutritional Need for Infants

A healthy, average breastfed infant requires approximate energy of:

200 Kcal, 6–8 Months

300 Kcal, 9–11 Months

550 Kcal, 12–23 Months

This amount of energy is required for the optimal growth and development of cognitive functions of the infant. The caregivers may not know the amount and measure of breastfeeding given and the complementary feed necessary to meet the above requirement. Therefore, what is required is responsive feeding including feeding on cues and hunger, encouraging children to eat and ensuring reduced distractions while feeding.

An ideal complementary food has to supply the required:

- 97% of Iron
- 86% of Zinc
- 81% of Phosphorus
- 76% of Magnesium
- 73% of Sodium
- 72% of Calcium

The diet containing relatively small and less dense complementary feed during 6–24 months will essentially leads to both macro and micronutrient deficiencies in later life.

In India, complementary foods are predominantly plant based which potentially lack some key nutrients that could be supplied by the addition of:

- Meat
- Poultry
- Fish
- Milk
- Vitamin A rich fruits and vegetables like papaya, mango, red carrots, ripe pumpkin

There is a worldwide debate about optimal requirement of fat considering the risk of too little and excessive intake of fats for infants. For an infant in India, consuming an average amount of breast milk with normal fat concentration (38 g/L) requires percentage of energy from fat in complementary foods:

- 0%–34% at 6–8 Months
- 5%–38% at 9–11 Months
- 17%–42% at 12–23 Months

Unappreciative Practices in Complementary Feeding in Some Indian Household

The practice and pattern of feeding in the initial 2 years of life is an important determining factor of under nourishment in India. At home, the decision taken by the mother of infant will determine how an infant and her child will be fed and this too is determined by the family and community she belongs too. At times old age or traditional fallacies surrounding complementary feeding such as the avoidance of cereals and pulses because they are considered difficult for the infant to digest can impact infant feeding.

Rural or semi urban families with restrictive mindsets may follow myths like diluting cow's milk and to infant or fresh juices given as complimentary feed as thought to produce parasites in the stomach. Some families believe jaggery, eggs, mangoes, and spicy foods are avoided in infants due to hot constitution foods causing diarrhea or prickly heat in infants.

Many mothers continue to breast feed exclusively beyond 6 months of age and do not initiate complimentary feeding thinking that the child will not be able to digest meals yet causing under nutrition in infant above 6 months of age. Since these myths and false beliefs on infant and young child feeding practices can be deep-rooted in families, as a pediatric health care provider awareness and education are required to deal with these issues and achieve optimum feeding.

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Balanced Diet for Infant and Young Children

As pediatric nutritionists it is realized that uniform guidelines cannot be followed for infant complementary feeding practices as it is not feasible considering the varying feeding practices in different regional and cultural areas in India. It is best to acknowledge population specific dietary guidelines for particular areas are developed to meet the nutritional needs of growing infants.

It is recommended that in a day as follows:

- Infants in age group 6 to 24 months should have a minimum of at least four out of seven locally available food groups such as dairy products, cereals, tubers, legumes and nuts, flesh foods, eggs, Vitamin A-rich fruits, and vegetables.
- The minimum meal frequency should be increased with increasing age of the child.
- For the average healthy breastfed infant, meals of complementary foods should be provided 2–3 times/day at 6–8 months of age and 3–4 times/ day at 9–11 and 12–24 months of age, with additional nutritious snacks (such as a piece of fruit or bread or chapatti with nut paste) offered 1–2 times/day, as desired.
- The feeding also depends on the energy density of the local foods and the amounts consumed at each feeding. The minimum diet diversity and meal frequency should meet the energy and other micronutrients required by the infants to grow healthily.

Clean and Hygienic Cooked Food

In order to prevent gastrointestinal infections in young infants the safe hygiene cooking practices for food preparation and feeding is important in children.

The best practices that need to be reinforced by pediatric health care counselors to mothers are as follows:

- Simple hygiene like hand washing before preparation and feeding.
- Safe storage of foods.
- Feeding directly after preparation.
- Using clean utensils for cooking infant's food.
- Avoiding bottle feeding.
- Encouraging family food as complementary feeding.

The pediatrician should share knowledge to the mother that scientific studies indicate that diarrhea is commonly observed in the second half year of infant's age and is associated with the nipples of milk feeding bottles contaminated with *Escherichia coli*.

It is seen that adapting to commercially available infant and complementary feeding reduces the duration of exclusive breastfeeding and replaces home-based complementary feeding which are more nutritious and economical.

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Fortification of Complementary Food Products

In India, complementary foods are predominantly plant based. Rice and wheat are used in complimentary foods along with pulses and vegetables. The fortification of foods with micronutrients and vitamin supplementation for mother ensures the maintenance of adequate concentrations in breast milk. In India, wheat flour fortified with iron and folic acid, multigrain flour supplementation fortified with iron, vegetable oils with Vitamin A, and milk fortified with Vitamin D are long-term strategies being used to combat micronutrient deficiencies.

Conclusion

Appropriate infant feeding practice is the essential early intervention for child health endurance. Empowering new mothers and their families to be proactive involved in promoting and supporting breast feedings and following weaning practices is essential. As health care providers in pediatric clinic, infant and young child feeding practice needs to be well addressed and all health-care professionals should upgrade skills to assist the mothers as the absence of knowledge of the scientific rationale behind age-appropriate feeding can be deterrent to the short as well as long-term nutritional policies for infant and young children feeding practices as national nutrition institutes of the country.

Check Your Progress

1. What type of diet is required for an infant?
2. When does complementary feeding starts in infants?
3. What is colostrum?
4. Define the term Exclusive breastfeeding.
5. Give the importance of exclusive breastfeeding.
6. How much energy is required by a healthy, average breastfed infant?

3.3 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Infant from birth to two years of age essentially require a diet that will meet the nutritional requirement for acceleration in the normal physical and mental growth.
2. Complementary feeding begins in infants after they complete 6 months of age and it is emphasizes repeatedly to be adequate, safe and proper.
3. According to the WHO global acknowledgement is given to colostrum as the perfect food for every newborn. Colostrum is the thick consistency, yellowish substance produced by the mother immediately after delivery and it last for first 2 to 4 days of child birth.

4. Exclusive breastfeeding is defined as the practice of giving only breast milk for the first 6 months of life no other foods or water.
5. The importance of exclusive breastfeeding is that it helps to drive global nutritional target diseases, such as stunting, anemia in the reproductive age group, low birth weight, childhood overweight, and wasting. Breastfeeding continued beyond 1 year of age provides essential fatty acids which are mostly not supplemented by complementary foods but essential for pre-carotenoid synthesis for Vitamin A.
6. A healthy, average breastfed infant requires approximate energy of:

   200 Kcal, 6–8 Months

   300 Kcal, 9–11 Months

   550 Kcal, 12–23 Months

3.4 SUMMARY

- The initial 24 months in every infant's life is pivotal to lay the foundation for optimal growth and development.
- Infant from birth to two years of age essentially require a diet that will meet the nutritional requirement for acceleration in the normal physical and mental growth.
- Every month after weaning from lactation, the diet is modified by adjusting to the requirements of energy, protein, vitamins, and iron along with calcium.
- An infant has a stomach which is small, comparable to size of its own two fists together and has limited capacity to ingest as compared to an adult. So, an infant cannot consume much at one meal, hence it is pivotal to prepare a meal that provides both micro nutrients including vitamins all minerals and macro nutrients inclusive of carbohydrates, protein and fat.
- The primary 180 days of life an infant requires exclusive breast feeding which is the best food for the baby. Nutrition in optimal amount is required for the growing infant needs.
- The lactation is provided on-demand and done frequently. Exclusive breast feeding meets all nutritional requirements of the infant for 6 months.
- Water is also not required in initial 6 months as the foremilk which is the milk at the beginning of feed has more water as compared to the hind milk which is last feed of the breast feeding.
- Complementary feeding begins in infants after they complete 6 months of age and it is emphasizes repeatedly to be adequate, safe and proper.
- Emphasis is on the first 1000 days of life to create the groundwork for growth and development of children.

NOTES

- According to the WHO global acknowledgement is given to colostrum as the perfect food for every newborn.
- Colostrum is the thick consistency, yellowish substance produced by the mother immediately after delivery and it last for first 2 to 4 days of child birth.
- The feeding and rearing practices of children, especially infants in developing countries, are rooted in cultural beliefs. Therefore, good communication and awareness are required to educate and eradicate these interferences of cultural practices.
- Exclusive breastfeeding is defined as the practice of giving only breast milk for the first 6 months of life.
- Exclusive breastfeeding meets all the nutritional needs of infants if the breastfeeding technique is followed appropriately.
- The importance of exclusive breastfeeding is that it helps to drive global nutritional target diseases, such as stunting, anemia in the reproductive age group, low birth weight, childhood overweight, and wasting.
- Advantages to mothers who exclusively breastfeed their infants include regaining their pre-pregnancy weight and delayed conception.
- In addition to breastfeeding, to meet the nutritional needs of the infant, complementary foods are added to the diet of the child.
- The transition from exclusive breastfeeding to family foods, referred to as complementary feeding, typically covers the period from 6 to 24 months of age, which is considered a very vulnerable period prone to malnutrition.
- Apart from energy requirement, certain micronutrients such as iron, zinc, and Vitamin A which are reduced in breastfeeding before 6 months should be supplemented in complementary feeding.
- Timely introduction of complementary feeding at 6–8 months is crucial.
- Early weaning leads to an increased risk of type 1 diabetes, obesity, celiac disease, and eczema, and late weaning after 8 months leads to deficiency of zinc, protein, iron, and Vitamins B and D.
- The diet containing relatively small and less dense complementary feed during 6–24 months will essentially leads to both macro and micronutrient deficiencies in later life.
- As pediatric nutritionists it is realized that uniform guidelines cannot be followed for infant complementary feeding practices as it is not feasible considering the varying feeding practices in different regional and cultural areas in India.
- In order to prevent gastrointestinal infections in young infants the safe hygienic cooking practices for food preparation and feeding is important in children.

3.5 KEY WORDS

NOTES

- **Exclusive breastfeeding**: Exclusive breastfeeding is defined as the practice of giving only breast milk for the first 6 months of life no other foods or water.
- **Lactation**: Lactation describes the secretion of milk from the mammary glands and the period of time that a mother lactates to feed her young.
- **Complementary feeding:** Complementary feeding is defined as giving infants food and liquid in addition to formula and/or breast milk, when breast milk and/or formula alone no longer meet the nutritional requirements of the infant.
- **Colostrum**: Colostrum is the thick consistency, yellowish substance produced by the mother immediately after delivery and it last for first 2 to 4 days of child birth.

3.6 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What is the nutritional requirement of an infant?
2. Write short note on lactation.
3. What is complementary feeding and when does it start?
4. Give some benefits of colostrum.
5. Why is exclusive breastfeeding important?
6. What is the importance of giving clean and hygienic food for infant?

Long-Answer Questions

1. Explain exclusive breastfeeding and the hindrances in exclusive breast feeding in India
2. Discuss about sensitization by health-care providers before discharge from hospital.
3. Describe in detail about complementary feeding.
4. What are the nutritional need for infants? Give a detailed overview.
5. Analyse the unappreciative practices in complementary feeding in some Indian households.
6. Explain about fortification of complementary food products.

3.7 FURTHER READINGS

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UNIT 4 IMMUNIZATION SCHEDULE

NOTES

Structure

4.0 Introduction
4.1 Objectives
4.2 Immunization Schedule During Pregnancy, Infancy and Childhood
    4.2.1 Immunization Schedule During Pregnancy
    4.2.2 Immunization in Infants
    4.2.3 Immunization in Children
4.3 Answers to Check Your Progress Questions
4.4 Summary
4.5 Key Words
4.6 Self Assessment Questions and Exercises
4.7 Further Readings

4.0 INTRODUCTION

Immunization during pregnancy is a simple and effective way to protect the mother and child from certain infections. The immunological changes occur during pregnancy which may be responsible for the susceptibility of certain infectious diseases that increases the risk of more serious outcomes. Vaccination of pregnant women can protect to mother against vaccine-preventable infections, and in so doing potentially protect the fetus. Immunization during pregnancy can also directly protect the fetus and infant via transferred of antibodies from the mother to the fetus. This is why vaccinations during pregnancy are so important. Vaccination during pregnancy is a cost-effective strategy to improve pregnancy outcomes in India. Globally, no scientific study exist which shows the risk of fetus after vaccination of pregnant women with inactivated vaccines or bacterial vaccines or toxoids. Even live vaccines causing risk to fetus is theoretical. Vaccination with inactivated virus, bacterial or toxoid in pregnancy is risk to a developing fetus during pregnancy is theoretical. But definitely the live vaccine poses a theoretical risk to a developing fetus. Therefore, all live vaccines should be avoided during pregnancy. The developing country like India where the people can't afford these vaccines, the government should be included these vaccines in routine immunization program.

Maternal immunization protects both the mother and fetus from the morbidity of certain infections. It can also provide the infant passive protection against vaccine-preventable infections acquired independently after birth. Ideally, immunizations are given prior to conception, but administration during pregnancy is indicated in some situations. A vaccination is a shot that contains a vaccine. A

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vaccine is a medicine that helps protect you from certain diseases. During pregnancy, vaccinations help protect both you your baby. Make sure your vaccinations are current before you get pregnant. And talk to your health care provider about vaccinations that are safe to get during pregnancy. Some infections are so serious even they can waste pregnancy, harm her baby during pregnancy or after delivery. These complications can be protected with vaccination. This is why vaccinations are so important for pregnant mothers. Vaccines strengthen the immune systems of body that can fight off serious infectious diseases.

In this unit, you will study about immunization schedule during pregnancy, infancy and childhood.

4.1 OBJECTIVES

After going through this unit, you will be able to:

- Discuss the immunization schedule during pregnancy
- Understand what are the vaccines given during infancy and childhood

4.2 IMMUNIZATION SCHEDULE DURING PREGNANCY, INFANCY AND CHILDHOOD

Immunization is the process where a person is made immune or resistant to an infectious disease, typically by the administration of a vaccine. Vaccines stimulate the body's own immune system to protect the person against subsequent infection or disease. Immunization of the mother during pregnancy is beneficially important for health benefits to both the pregnant women and baby. Vaccine preventable illnesses can be significant avoided and do have marked reduction in morbidity and mortality amongst the vulnerable section of population which is the maternal, neonatal, and young infant.

Certain infections can severely affect pregnancy, harm the baby during pregnancy or have implications post delivery. The severity of complications can be prevented with successful vaccination. Vaccinations are essentially important for pregnant mother to protect the infant. Vaccines strengthen the immune systems of body that can fight off serious infectious diseases.

4.2.1 Immunization Schedule During Pregnancy

Immunization helps in providing protection to the mother's body from infections and this immunity passes to her baby during pregnancy. The immunity from mother to the child will ensure safety during the first few months of life until baby will get own vaccination. Vaccination protects maternity months of a woman from getting a sickness that could affect future pregnancies.

Benefits of vaccinating pregnant women usually outweigh potential risks when the likelihood of disease exposure is high, when infection would pose a risk to the mother or baby in womb, and when the vaccine is unlikely to cause harm.

Not all vaccinations are safe during pregnancy but some of inactivated vaccines are considered safe which can be give to pregnant women who might be at risk of infection.

Tetanus Vaccine

Tetanus is a primary reason of morbidity in the pregnant mother due to the toxin of bacterium called *Clostridium Tetani* that is found in the soil and causes bacterial disease. Tetanus by the release of toxin of the bacterium that potentially enters the human body through an open wound or a deep puncture wound, such as a bite, cut, burn or an ulcer will affect the nervous system and is fatal incase left untreated. Neonatal tetanus affects newborn babies through the infection of the unhealed umbilical stump which is observed in callous clinical condition when the stump may have been cut with a non-sterile instrument which is generally observed in resource poor maternity wards/home delivery in rural or tough terrains.

Tetanus can be prevented only through vaccination. The vaccine of Tetanus contain a non-infectious toxoid that appears safe during pregnancy and are administered in many countries of the world to prevent neonatal tetanus.

The reports from World Health Organization (WHO) state that neonatal tetanus causes mortality of over 200,000 newborns each year almost all these deaths occur in developing countries while it is rarely observed in developed nations.

The national immunization schedule in India recommends in order maximizing the maternal antibody response and passive antibody transfer to the infant:

- Two doses of Tetanus Toxoid (TT) for immunization status of pregnant women that is unverified. The first dose of tetanus toxoid is administered as soon as pregnancy is detected.
- Second dose of tetanus toxoid is administered after 4 weeks and if a mother received 2 TT doses in the last pregnancy and mother gets again pregnant with in 3 year than only one dose of TT is recommended and that dose is called booster dose.

Experts suggest that the second dose of the vaccine should be given 4 weeks prior to the expected date of delivery.

The WHO also prefers that a third vaccine should be given 6 months after the second one to provide protection for at least 5 years. After TT vaccination, the antibodies formed in mother are transferred to baby and protect baby for a few months after birth. TT vaccination also helps to prevent premature birth or delivery.

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Hepatitis B Vaccine

Hepatitis B infection is an inflammation of the liver which is very serious which is caused by Hepatitis B Virus (HBV). Hepatitis B infection in a pregnant woman may increase the chance of preterm birth. However, there is no study which indicates that hepatitis B infection is not associated with high abortion rates, stillbirth or congenital fetal malformation.

The primary concern is the vertical transmission of infection from mother to child. It has been observed that 70% to 90% of babies will remain chronically infected with hepatitis B even into adult life and have a high probability of developing liver cirrhosis and hepatocellular carcinoma.

Medical studies have confirmed that no adverse affects on pregnancy is reported after vaccination is done with Hepatitis B vaccine during gestation.

A pregnant mother reported of hepatitis B surface antigen, i.e., HBsAg-positive should be ensured that her infant receives Hepatitis B Immunoglobulin and to initiate the hepatitis B vaccine schedule within 12 hours after birth and that the infant completes the recommended HepB vaccine schedule.

Influenza Vaccine

Influenza is a viral infection that attacks your respiratory system — your nose, throat and lungs. Influenza is commonly called the flu, but it is not the same as stomach flu viruses that cause diarrhea and vomiting. Influenza is a cause of severe illness in pregnant women. An infection due to Influenza in pregnancy can have a chance for serious problems for the baby and increasing risk of premature labor and delivery. Women in the second and third trimesters of pregnancy are at increased risk for hospitalization from influenza. Therefore, routine inactivated influenza vaccine is recommended for all women who will be pregnant (in any trimester) during influenza season.

The available inactivated influenza vaccines for the control of seasonal influenza are safe and efficacious and have the potential to prevent significant morbidity and mortality in pregnant women. Live attenuated influenza vaccine is available in form of an intranasal spray and that is not recommended for pregnant women.

Maternal influenza immunization offers demonstrated disease prevention benefits for women and their newborns and is a critically important component during pregnancy. Pregnant women should be counseled about the benefits of the influenza vaccine for themselves and their unborn baby.

Hepatitis A Vaccine

Hepatitis A is a liver infection caused by the Hepatitis A virus. Globally, an estimated 1.4 million cases of Hepatitis A Virus (HAV) infection occurs every year. The Integrated Disease Surveillance Program of the National Center for Disease Control

reported 290,000 cases of acute viral hepatitis in 2013. It is acquired via the fecal-oral route by ingestion of contaminated food or water.

Hepatitis A vaccines are derived from viruses grown in diploid cell cultures and are formalin inactivated. Safety of hepatitis A vaccination during pregnancy has not been determined. Because hepatitis A vaccine is produced from inactivated virus, the risk to the developing fetus is expected to be low. Therefore, theoretic risks of vaccination should be weighed against the risk for hepatitis A infection in pregnant women who may be at risk for exposure.

Finally, if a pregnant woman is exposed to hepatitis A infection, the immune globulin is strongly recommended; the immunoglobulin is considered safe and is more than 85 percent effective in preventing acute hepatitis infection during pregnancy.

Live attenuated virus is a vaccine that could cross the placenta and result in viral infection to the fetus. That why, most of live attenuated vaccines like Measles, Mumps, Rubella, Varicella, Meningococcal, Human Papilloma Virus (HPV) vaccine and Pneumococcal polysaccharide vaccine, Oral Polio Vaccine (OPV), Inactivated Polio Vaccine (IPV), Typhoid vaccine, Cholera vaccine, Plague vaccine, Japanese encephalitis vaccines are strongly contraindicated in pregnant women.

In our country there are barriers to effective vaccination during pregnancy due to unawareness of the possible benefits and lack of concerns about vaccine safety. Moreover financial constraints in the developing country where the citizens cannot afford vaccines or have access to public health care system the government should be included these vaccines in routine immunization program.

Is Immunization in Pregnancy Safe?

Vaccine-preventable infectious diseases are responsible for significant maternal, neonatal, and young infant morbidity and mortality. While there is emerging scientific evidence, as well as theoretical considerations, indicating that certain vaccines are safe for pregnant women and fetuses, policy formulation is challenging because of perceived potential risks to the fetus.

No evidence of adverse pregnancy outcomes has been identified from immunization of pregnant women with vaccines.

The immunization of pregnant women or women of reproductive age has multiple purposes:

- To protect the mother.
- To protect the newborn and infant.
- To prevent diseases and complications of pregnancy.

4.2.2 Immunization in Infants

Infants should get immunized during their first two years of life. A child may need several doses of the vaccines to be fully protected. For example, healthcare providers recommend that infants receive their first dose of MMR (Measles,

Mumps, Rubella) vaccination at 12 months of age or older and a second dose prior to elementary school entry (around 4 to 6 years of age). Children can get the vaccines at regularly scheduled well visits.

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Importance of Vaccines for Infant

For newborns, breast milk can help protect against many diseases. However, this immunity wears off after breastfeeding is over, and some children are not breastfed at all. Whether or not children are breastfed, vaccines can help protect them from disease. Vaccines can also help prevent the spread of disease through the rest of the population through herd immunity.

Vaccines work by imitating infection of a certain disease (but not its symptoms) in child's body. This prompts child's immune system to develop weapons called antibodies. These antibodies fight the disease that the vaccine is meant to prevent. With their body now primed to make antibodies, your child's immune system can defeat future infection from the disease.

Vaccination Schedule

Vaccinations are not all given right after a baby is born. Each is given on a different timeline. They are mostly spaced throughout the first 24 months of child's life, and many are given in several stages or doses. An outline of the recommended vaccination timeline is shown below. Recommended age at which the vaccines should be received and type of vaccine:

At Birth

Hepatitis B: Hepatitis B vaccine. Ideally, the first dose is given within 24 hours of birth, but kids not previously immunized can get it at any age. Some low birth weight infants will get it at 1 month or when they are discharged from the hospital. Second dose should be given 1 to 2 months after the first dose.

2 Months of Age

- DTaP - Diphtheria, Tetanus, Acellular Pertussis
- IVP - Inactivated Polio vaccine
- Hepatitis B
- Pneumococcal Vaccine
- HIB - *Haemophilus influenza* Type B
- Rotavirus Vaccine

4 Months of Age

- DTaP
- IVP
- Pneumococcal Vaccine
- HIB
- Rotavirus Vaccine

6 Months of Age

- DTaP
- IVP
- Hepatitis B
- Pneumococcal Vaccine
- HIB
- Influenza Vaccine
- Rotavirus Vaccine

12 Months of Age

- MMR - Measles, Mumps, Rubella
- Pneumococcal Vaccine
- Hepatitis A

15 Months of Age

- DTaP
- HIB
- Varicella

18 Months of Age

Hepatitis A

Between 12 and 23 months of age, your baby should receive vaccines to protect them from the following diseases:

- Chickenpox (Varicella) (1st dose)
- Diphtheria, tetanus, and whooping cough (pertussis) (DTaP) (4th dose)
- Haemophilus influenzae type b disease (Hib) (4th dose)
- Measles, mumps, and rubella (MMR) (1st dose)
- Polio (IPV) (3rd dose)
- Pneumococcal disease (PCV13) (4th dose)
- Hepatitis A (HepA) (1st dose)
- Hepatitis B (HepB) (3rd dose between 6 months and 18 months)
- Influenza (Flu) (every year)

Types of Vaccines

Following are the types of vaccines:

Hepatitis B: Three doses of the hepatitis B vaccine are generally given – the first dose is usually given within 12 hours of birth, the second at about 2 months, and the third at about 6 months of age. Slight variations in this schedule are possible based on the mother's hepatitis B surface antigen status and the potential use of combination vaccines.

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Diphtheria, Tetanus, Pertussis: Five doses of the diphtheria, tetanus, pertussis combination vaccine are given, with the first dose usually given at 2 months of age, the second at 4 months, the third at 6 months, the fourth at about 15 months of age, and the fifth at about 5 years of age. Slight variations in this schedule are possible.

Inactivated Polio: Four doses of the inactivated polio vaccine are given, with the first dose given at 2 months, the second at 4 months, the third at about 6 months, and the fourth at about 5 years of age.

Pediarix: Pediarix is a combination vaccine that can help protect against five serious diseases: diphtheria, tetanus, pertussis (whooping cough), hepatitis B, and polio. Pediarix is typically given at 2, 4, and 6 months of age.

***Haemophilus influenzae* Type B:** Four doses of *Haemophilus influenzae* type B vaccine are given. The first at 2 months, the second at 4 months, the third at 6 months, and the fourth at about 12 months of age. Slight variations in this schedule are possible.

RotaTeq: RotaTeq is a vaccine that can help protect against rotavirus, which is a viral infection that can cause fever, vomiting, and diarrhea. The vaccine is given by mouth at three different times, each about one to two months apart.

Measles, Mumps, Rubella: Two doses of the measles, mumps, and rubella combination vaccine are given, with the first dose given at about 12 months of age and the second given at about 5 years of age.

Pneumococcal Vaccine: Four doses of the pneumococcal vaccine are usually given. The first is given at 2 months of age, the second at 4 months, the third at 6 months, and the fourth at about 12 months of age.

Hepatitis A: The hepatitis A vaccine is given to protect against one type of hepatitis, hepatitis A. Hepatitis is a type of liver disease. The vaccine is typically given as a two-dose series, with the first shot given at the age of 1 and the second around 6 months later.

After Vaccinations

Sometimes children have mild reactions from vaccines, such as pain at the injection site, a rash, or a fever. These reactions are normal and will soon go away.

- Read the Vaccine Information Sheet(s) your child's doctor gave you to learn about side effects your child may experience.
- Offer breastmilk and liquids more often. It is normal for some children to eat less during the 24 hours after getting vaccines.
- Pay extra attention to your child for a few days. If you see something that concerns you, call your child's doctor.

4.2.3 Immunization in Children

In 1974: the Expanded Program of Immunization (EPI) was introduced, globally and in India, the initial EPI program included:

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- Bacillus Calmette-Guérin (BCG)
- Diphtheria
- Tetanus Toxoids
- Whole Cell Pertussis (DTwP)
- Oral Poliomyelitis
- Typhoid Vaccines

In 1985: The Universal Immunization Program (UIP) improved the immunization coverage and extended the focus beyond infancy. Measles vaccine was added and Typhoid vaccine was excluded from the schedule.

In 1990: Vitamin A supplementation was included.

1995: The Polio National Immunization Days introduced.

2002: Some states introduced hepatitis B vaccine.

2011: A pentavalent vaccine, Haemophilus influenzae [b-HiB] and hepatitis B with DTwP).

UIP is an essential part of the Child Survival and Safe Motherhood Program since 1992, the Reproductive and Child Health Program (RCH-I) from 1997, and the RCH-II and National Rural Health Mission since 2005.

Indian Academy of Pediatrics 2014 Guidelines

The Indian Academy of Pediatrics Advisory Committee on Vaccines and Immunization Practices recommended immunization of children until the age of 18 years based on the recent evidence of the licensed vaccines in the country. Attached are the schedules for children that are followed in the country for immunization.

Recommended age at which the vaccines should be received and type of vaccine:

4 to 6 Years of Age

- DTaP
- MMR
- IVP
- Varicella

11–12 Years

- **HPV:** Human Papillomavirus Vaccine, given in 2 shots over a 6- to 12-month period. It can be given as early as age 9. For teens and young adults (ages 15–26 in girls and boys both), it is given in 3 shots over 6 months. It's recommended for both girls and boys to prevent genital warts and some types of cancer.
- **Tdap:** Tetanus, diphtheria, and pertussis booster. Also recommended during each pregnancy a woman has.

- **Meningococcal Conjugate Vaccine:** And a booster dose is recommended at age 16.

16–18 Years

- **Meningococcal B Vaccine (MenB):** The MenB vaccine is given to kids and teens in 2 or 3 doses, depending on the brand. Unlike the meningococcal conjugate vaccine, which is recommended, the decision to get the MenB vaccine is made by the teens, their parents, and the doctor.
- **The Flu Vaccine** is especially important for kids who are at risk for health problems from the flu. High-risk groups include, but are not limited to, kids younger than 5 years old and those with chronic medical conditions, such as asthma, heart problems, sickle cell disease, diabetes, or HIV.
- **Pneumococcal Vaccines** can be given to older kids (age 2 and up) who have conditions that affect their immune systems, such as asplenia or HIV infection, or other conditions, like a cochlear implant, chronic heart disease, or chronic lung disease.

When Should a Child not be Vaccinated?

In a few cases, it's better to wait to get a vaccine. Some children who are very sick should not get a vaccine at all. Reasons that you should wait or not get a vaccine may include:

- Being sick with something more serious than a cold.
- Having a bad reaction after the first dose of a vaccine.
- Having a convulsion (sudden jerky body movements) that is thought to be caused by a vaccine.

Check Your Progress

1. How is immunization helpful?
2. Give the benefits of vaccinating pregnant women.
3. How is tetanus caused?
4. What is hepatitis B infection?
5. Is influenza in pregnancy dangerous?
6. How is immunization of pregnant women or women of reproductive age helpful?
7. When should infants get immunized?
8. What is the vaccination schedule of an infant?
9. Name the vaccines that an infant should get at the age of 4 months.
10. What are the vaccines that a child should get at the age of 4 to 6 years?
11. Why is flu vaccine important?
12. Which age group children are given pneumococcal vaccines?

4.3 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

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1. Immunization helps in providing protection to the mother's body from infections and this immunity passes to her baby during pregnancy.
2. Benefits of vaccinating pregnant women usually outweigh potential risks when the likelihood of disease exposure is high, when infection would pose a risk to the mother or baby in womb, and when the vaccine is unlikely to cause harm.
3. Tetanus is a primary reason of morbidity in the pregnant mother due to the toxin of bacterium called *Clostridium Tetani* that is found in the soil and causes bacterial disease.
4. Hepatitis B infection is an inflammation of the liver which is very serious which is caused by Hepatitis B Virus (HBV). Hepatitis B infection in a pregnant woman may increase the chance of preterm birth. However, there is no study which indicates that hepatitis B infection is not associated with high abortion rates, stillbirth or congenital fetal malformation.
5. An infection due to influenza in pregnancy can have a chance for serious problems for the baby and increasing risk of premature labor and delivery. Women in the second and third trimesters of pregnancy are at increased risk for hospitalization from influenza.
6. The immunization of pregnant women or women of reproductive age has multiple purposes:
   - To protect the mother
   - To protect the newborn and infant
   - To prevent diseases and complications of pregnancy
7. Infants should get immunized during their first two years of life. A child may need several doses of the vaccines to be fully protected. For example, healthcare providers recommend that infants receive their first dose of MMR (Measles, Mumps, Rubella) vaccination at 12 months of age or older and a second dose prior to elementary school entry (around 4 to 6 years of age).
8. Vaccinations are not all given right after a baby is born. Each is given on a different timeline. They are mostly spaced throughout the first 24 months of child's life, and many are given in several stages or doses. An outline of the recommended vaccination timeline is shown below.
9. The vaccines that an infant should get at the age of 4 months are as follows:
   - DTaP
   - IVP
   - Pneumococcal Vaccine

- HIB
- Rotavirus Vaccine

10. The vaccines that a child should get at the age of 4 to 6 years are as follows:
    - DTaP
    - MMR
    - IVP
    - Varicella
11. The flu vaccine is especially important for kids who are at risk for health problems from the flu. High-risk groups include, but are not limited to, kids younger than 5 years old and those with chronic medical conditions, such as asthma, heart problems, sickle cell disease, diabetes, or HIV.
12. Pneumococcal vaccines can be given to older kids (age 2 and up) who have conditions that affect their immune systems, such as asplenia or HIV infection, or other conditions, like a cochlear implant, chronic heart disease, or chronic lung disease.

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4.4 SUMMARY

- Immunization is the process whereby a person is made immune or resistant to an infectious disease, typically by the administration of a vaccine.
- Vaccines stimulate the body's own immune system to protect the person against subsequent infection or disease.
- Immunization of the mother during pregnancy is beneficially important for health benefits to both the pregnant women and baby.
- Certain infections can severely affect pregnancy, harm the baby during pregnancy or have implications post-delivery.
- Vaccinations are essentially important for pregnant mother to protect the infant. Vaccines strengthen the immune systems of body that can fight off serious infectious diseases.
- Immunization helps in providing protection to the mother's body from infections and this immunity passes to her baby during pregnancy.
- The immunity from mother to the child ensures safety during the first few months of life until baby will get own vaccination.
- Benefits of vaccinating pregnant women usually outweigh potential risks when the likelihood of disease exposure is high, when infection would pose a risk to the mother or baby in womb, and when the vaccine is unlikely to cause harm.

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- Not all vaccinations are safe during pregnancy but some of inactivated vaccines are considered safe which can be given to pregnant women who might be at risk of infection.
- Tetanus is a primary reason of morbidity in the pregnant mother due to the toxin of bacterium called *Clostridium Tetani* that is found in the soil and causes bacterial disease.
- Neonatal tetanus affects newborn babies through the infection of the unhealed umbilical stump which is observed in callous clinical condition when the stump may have been cut with a non-sterile instrument which is generally observed in resource poor maternity wards/home delivery in rural or tough terrains.
- Tetanus can be prevented only through vaccination. The vaccine of Tetanus contain a non-infectious toxoid that appears safe during pregnancy and are administered in many countries of the world to prevent neonatal tetanus.
- The reports from World Health Organization (WHO) state that neonatal tetanus causes mortality of over 200,000 newborns each year almost all these deaths occur in developing countries while it is rarely observed in developed nations.
- Two doses of Tetanus Toxoid (TT) for immunization status of pregnant women that is unverified. The first dose of tetanus toxoid is administered as soon as pregnancy is detected.
- Second dose of tetanus toxoid is administered after 4 weeks and if a mother received 2 TT doses in the last pregnancy and mother gets again pregnant with in 3 year than only one dose of TT is recommended and that dose is called booster dose.
- The WHO also prefers that a third vaccine should be given 6 months after the second one to provide protection for at least 5 years.
- After TT vaccination, the antibodies formed in mother are transferred to baby and protect baby for a few months after birth. TT vaccination also helps to prevent premature birth or delivery.
- Hepatitis B infection in a pregnant woman may increase the chance of preterm birth.
- Medical studies have confirmed that no adverse effects on pregnancy is reported after vaccination is done with Hepatitis B vaccine during gestation.
- Influenza is a cause of severe illness in pregnant women. An infection due to Influenza in pregnancy can have a chance for serious problems for the baby and increasing risk of premature labor and delivery.
- Women in the second and third trimesters of pregnancy are at increased risk for hospitalization from influenza.

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- Hepatitis A vaccines are derived from viruses grown in diploid cell cultures and are formalin inactivated.
- Vaccine-preventable infectious diseases are responsible for significant maternal, neonatal, and young infant morbidity and mortality.
- Infants should get immunized during their first two years of life. A child may need several doses of the vaccines to be fully protected.
- For newborns, breast milk can help protect against many diseases. However, this immunity wears off after breastfeeding is over, and some children are not breastfed at all.
- Vaccines can also help prevent the spread of disease through the rest of the population through herd immunity.
- Vaccines work by imitating infection of a certain disease (but not its symptoms) in child's body. This prompts child's immune system to develop weapons called antibodies.
- Vaccinations are not all given right after a baby is born. Each is given on a different timeline. They are mostly spaced throughout the first 24 months of child's life, and many are given in several stages or doses.
- Three doses of the hepatitis B vaccine are generally given – the first dose is usually given within 12 hours of birth, the second at about 2 months, and the third at about 6 months of age.
- Five doses of the diphtheria, tetanus, pertussis combination vaccine are given, with the first dose usually given at 2 months of age, the second at 4 months, the third at 6 months, the fourth at about 15 months of age, and the fifth at about 5 years of age.
- Four doses of the inactivated polio vaccine are given, with the first dose given at 2 months, the second at 4 months, the third at about 6 months, and the fourth at about 5 years of age.
- Pediarix is a combination vaccine that can help protect against five serious diseases: diphtheria, tetanus, pertussis (whooping cough), hepatitis B, and polio.
- Four doses of *Haemophilus influenzae* type B vaccine are given. The first at 2 months, the second at 4 months, the third at 6 months, and the fourth at about 12 months of age.
- RotaTeq is a vaccine that can help protect against rotavirus, which is a viral infection that can cause fever, vomiting, and diarrhea. The vaccine is given by mouth at three different times, each about one to two months apart.
- Two doses of the measles, mumps, and rubella combination vaccine are given, with the first dose given at about 12 months of age and the second given at about 5 years of age.

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- Four doses of the pneumococcal vaccine are usually given. The first is given at 2 months of age, the second at 4 months, the third at 6 months, and the fourth at about 12 months of age.
- The Flu Vaccine is especially important for kids who are at risk for health problems from the flu.
- Pneumococcal Vaccines can be given to older kids (age 2 and up) who have conditions that affect their immune systems, such as asplenia or HIV infection, or other conditions, like a cochlear implant, chronic heart disease, or chronic lung disease.

4.5 KEY WORDS

- **Immunization**: Immunization is the process whereby a person is made immune or resistant to an infectious disease, typically by the administration of a vaccine.
- **Hepatitis B**: Hepatitis B infection is an inflammation of the liver which is very serious which is caused by Hepatitis B Virus (HBV).
- **Influenza**: Influenza is a viral infection that attacks your respiratory system, i.e., your nose, throat and lungs.

4.6 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. Why is immunization important in pregnant ladies?
2. What is Tetanus? When is it given?
3. How and when the vaccine for influenza given?
4. Distinguish between Hepatitis A and Hepatitis B disease and vaccine.
5. Is immunization in pregnancy safe?
6. Why is the vaccines important for infants?
7. What are the vaccines that are given to infants between 12 to 23 months of age?
8. What are the guidelines given by Indian academy of pediatrics?

Long-Answer Questions

1. Discuss the immunization schedule during pregnancy.
2. Explain the immunization in infants.
3. Describe in detail the vaccination schedule of infants.

4. Elaborate a note on types of vaccines given to infants.
5. Write a descriptive note on immunization in children and its importance.

NOTES

4.7 FURTHER READINGS

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BLOCK - II
NUTRITIONAL MANAGEMENT OF INFANTS AND NEWBORN SICKNESS

UNIT 5 NUTRITIONAL MANAGEMENT

Structure

5.0 Introduction
5.1 Objectives
5.2 Nutritional Management of Premature Baby, Low Birth Weight Babies and Children with Developmental Disabilities
5.2.1 Nutritional Management of Premature Baby
5.2.2 Nutrition for Low Birth Weight Infant
5.2.3 Nutrition in Infants with Developmental Disabilities
5.3 Answers to Check Your Progress Questions
5.4 Summary
5.5 Key Words
5.6 Self Assessment Questions and Exercises
5.7 Further Readings

5.0 INTRODUCTION

Premature infants have greater nutritional needs in the neonatal period than at any other time of their lives. The nutrient needs are inherently high at this stage of development to match the high rates of nutrient deposition achieved by infants in utero. In addition, they often have medical conditions that increase their metabolic energy requirements, including hypotension, hypoxia, acidosis, infection, and surgery. Additional impediments to growth are physiologic immaturity of the gastrointestinal tract, including decreased gastrointestinal motility and reduced intestinal enzyme activity, and therapies such as corticosteroids.

Early and adequate nutritional support is needed to achieve appropriate rates of weight gain, which are almost twice that of a term infant, and to avoid postnatal growth failure. Despite intensive nutritional strategies for premature infants, growth failure remains a major problem. However, intensive feeding strategies must be balanced with potential risks. As an example, while early initiation of enteral feedings has been shown to benefit premature infants, very rapid advancements of enteral feedings may result in feeding intolerance or Necrotizing EnteroColitis (NEC). In addition, it is important to choose feeding practices associated with improved outcomes for premature infants, such as the use of human milk rather than formula. In some cases, when it is not possible to provide full

enteral feedings due to an infant's medical condition, it may be necessary to provide partial or total parenteral nutrition.

Low Birth Weight (LBW) is defined by the World Health Organization (WHO) as weight at birth less than 2500 g. The global prevalence of LBW is 15.5%, which means that about 20.6 million such infants are born each year, 96.5% of them in developing countries. LBW can be a consequence of preterm birth, or due to small size for gestational age, or both. In addition, depending on the birth weight reference used, a variable but small proportion of LBW infants are born at term and are not Small for Gestational Age (SGA). Intrauterine growth restriction, defined as a slower than normal rate of fetal growth, is usually responsible for SGA. LBW thus defines a heterogeneous group of infants: some are born early, some are born at term but are SGA, and some are both born early and SGA. Being born with LBW is generally recognized as a disadvantage for the infant. LBW infants are at higher risk of early growth retardation, infectious disease, developmental delay and death during infancy and childhood.

Children with developmental disabilities are at high risk for malnutrition. Severe nutritional problems can be prevented through routine screening, timely assessment, and appropriate intervention.

In this unit, you will study about nutritional management of premature baby, low birth weight babies and children with developmental disabilities.

5.1 OBJECTIVES

After going through this unit, you will be able to:

- Discuss the nutritional management of premature baby
- Explain the nutritional management of low birth weight babies
- Understand how nutrition are managed in children with developmental disabilities

5.2 NUTRITIONAL MANAGEMENT OF PREMATURE BABY, LOW BIRTH WEIGHT BABIES AND CHILDREN WITH DEVELOPMENTAL DISABILITIES

Nutritional management of premature baby, low birth weight babies and children with developmental disabilities are explained as follows:

5.2.1 Nutritional Management of Premature Baby

A baby born before the 37th week is known as a premature or preterm baby. A preterm baby is delivered before 37 weeks of pregnancy are completed.

NOTES

The preterm birth is categorized based on gestational age:

- Extremely Preterm (Less Than 28 Weeks)
- Very Preterm (28 to 32 Weeks)
- Moderate to Late Preterm (32 to 37 Weeks)

Premature infants are categorized by birth weight:

- < 1000 g: Extremely Low Birth Weight (ELBW)
- 1000 to 1499 g: Very Low Birth Weight (VLBW)
- 1500 to 2500 g: Low Birth Weight (LBW)

A preterm birth may happen spontaneously, but some births are probably due to early induction of labour or caesarean birth, whether for medical or non-medical reasons.

Known maternal causes of preterm birth include:

- Multiple pregnancies
- Infections
- Chronic conditions, such as diabetes and high blood pressure
- Genetic influence

The premature infant is petite and generally weighs less than 2.5 kg.

The physical perception of the child indicates:

- An appearance of thin, shiny, pink skin through which the underlying veins are easily seen.
- Little subcutaneous fat, hair, or external ear cartilage exists.
- Spontaneous activity and tone are reduced, and extremities are not held in the flexed position typical of term infants.

Monitoring infant's progress and frequent weight assessments are necessary to optimize growth and nutrition in preterm infants. Weight is monitored closely in the initial days as there is a contraction of the extracellular volume and possibility dehydration with severe hypernatremia. The infant's weight, length, and head circumference is assessed weekly and plotted on an appropriate growth chart.

Nutrition Management Plays a Critical Role in Care of Preterm Infant

The primary goal of nutrition of the infant born preterm is to:

- Source nutrients to provide for the growth rate as well as body composition compared to that of the healthy baby of the same gestational age in terms of weight, length, and head circumference, organ size, tissue components including cell number and structure, concentrations of blood and tissue nutrients, and developmental outcomes.

NOTES

- In case of delay or incompetency to provide these necessary amounts of all of the essential nutrients to preterm infants may be causative reason for growth failure of the infant while increasing the risk of life morbidity along with probably reducing optimal brain growth that limits neurodevelopment.
- It is a common observation that preterm infants do not thrive after birth due to decline in weight as a result of normal extracellular water loss or probably cannot keep up with intrauterine growth rates.
- The primary reason for this postnatal growth failure is under nutrition. This initiated from birth and continues for many days, as evidenced by cumulative protein and energy deficits.

Whereas an enhanced nutrition of very preterm infants, both IntraVenous (IV) and enteral, beginning right after birth promotes positive energy and protein balance and improves longer term neurodevelopmental outcomes.

In the First Week

- Protein and energy intakes are associated with 18-month developmental outcomes even in Extremely Low Birth Weight (ELBW), extremely preterm infants.
- Observation in study indicates that every 1 g/kg/day increase in protein intake was associated with an 8.2 point increase in mental developmental index at 18 months and every 10 kcal/kg/day increase in energy intake was associated with a 4.6 point increase in mental development index at 18 months.
- We see a lower risk of severe Retinopathy Of Prematurity (ROP) when weight gain approaches that of the normally growing fetus.
- There is a benefit of prevention of later life chronic diseases.
- Reasons for failure to provide sufficient nutrition to preterm infants are many, including a delayed start to providing nutrients, for example low or no IV amino acids on day 1 (to sometimes several days after birth) and enteral feedings often are held, sometimes for days; the amount of nutrient supplies are low, for example IV amino acid infusion rates of <2 g/kg/day; advancements of IV amino acids are slow even after starting early; advancements of enteral feeds are delayed; dilute nutritional mixes are used, for example unfortified breast milk (mother's own or banked); and there often are insufficient essential amino acids in currently available IV amino acid solutions. There also are numerous reasons that come up during ordinary neonatal care after birth for not starting, slowly advancing, or stopping nutrition, IV or enteral, usually for unsubstantiated concerns for metabolic toxicities, feeding intolerance, risk of Necrotizing EnteroColitis (NEC), or other common neonatal morbidities.

NOTES

- Regardless of the reason, the end result is under nutrition and less than optimal growth, in terms of weight, length, head circumference, and body composition. Under nutrition is a critical problem in preterm infants, as these infants are at critical stages of development when insufficient nutrient substrates and anabolic (growth promoting) hormones that are produced in response lead to growth failure and long-lasting neuro-developmental outcomes.
- Therefore, we need to know the nutrients and their rates of administration for preterm infants that would match preterm neonatal metabolism and growth to fetal metabolism and growth at the same gestational age, and maintain normal concentrations of blood and tissue nutrients. We also need to review methods of providing nutrients that are safe and effective, but are necessarily different according to postnatal age and metabolic and feeding capacities.

Infant Nutrition Preparation

The medical management to optimize the benefits of enhanced and improved nutrition in very preterm infant's right after birth.

- Preterm infants have to be monitored clinically as their physiology after birth needs attention.
- Clinical manifestations indicate that preterm babies have low and high oxygen concentrations.
- Their glucose concentrations fluctuate significantly.
- Blood pressure and organ perfusion often is highly variable and often low.
- They produce significant amounts of counter-regulatory hormones, such as adrenaline (principally norepinephrine), cortisol, glucagon and growth hormone that promote variable changes in cardiac output, organ perfusion, and glucose and oxygen values.
- Good medical care can help reduce these problems and improve the capacity to start parenteral and enteral nutrition sooner and advance more effectively.

IV (Parenteral) Feeding

IV feeding, including amino acids is generally started right after birth at rates that are appropriate for the gestational age of the infant. The IV nutrition is fundamental in all infants who cannot tolerate full enteral feedings. Metabolic and thus nutritional requirements do not stop with birth; this includes protein accretion. IV feeding is always indicated when normal metabolic needs are not met by normal enteral feeding. The smaller the infant, the less body stores (protein, fat, and glycogen) are available to provide nutrients for metabolic needs. The metabolic and thus nutrient requirements of the newborn are equal to or greater than those of the fetus of the same gestational age. It is reasonable, therefore to provide the preterm infant with at least what the fetus of the same gestational age receives for nutrition to maintain normal metabolism.

NOTES

IV Dextrose (Glucose) Infusion

A common approach to early IV dextrose is to infuse at 6 to 8 mg/kg/minute beginning at birth, increasing to 12 to 14 µg/minute/kg for full IV nutrition (~70–80 kcal/kg/day). But, the normal Glucose Utilization Rate (GUR) is maximal at ~6–7 µg/kg/minute in preterm infants (largely for the brain and heart), and preterm infants quickly develop and maintain hepatic glucose production rates of 2 to 3 µg/kg/minute, which do not get shut down by dextrose infusion or normal to high glucose and insulin concentrations .

Therefore, if one infuses 6 to 8 µg/kg/minute dextrose, total glucose entry is 8 to 11 µg/kg/minute, in excess of maximal Glucose Utilization Rate (GUR), leading to hyperglycemia, which gets even worse when the Glucose Infusion Rate (GIR) is increased to 12 to 14 µg/kg/minute, especially if stress conditions develop and/or catecholamines, glucocorticoids, and high rates of IV lipid are infused for other medical conditions.

Low glucose values (hypoglycemia) are less common in preterm infants due to early and relatively high rates of IV dextrose infusions. Studies have shown that such management is associated with normal school age neurodevelopment and cognitive outcomes.

Extremely low glucose concentrations should be corrected immediately with increased IV dextrose infusion rates. Bolus glucose infusions are only indicated when severe signs of hypoglycemia, such as seizures or coma, are present.

Hyperglycemia is best prevented by starting with lower dextrose infusion rates, 3 to 4 µg/minute/kg, increasing or decreasing as needed to maintain glucose concentrations within the normal fetal level glucose concentration range, greater than 3 mMol/L and less than 6 mMol/L, in response to frequent plasma glucose concentration measurements to prevent hypo- and hyperglycemia.

High glucose values are common and potentially deleterious, and are compounded by other risks for hyperglycemia, including reduced insulin secretion, limited enteral feedings with diminished secretion of incretins that promote insulin secretion, stress of all kinds but particularly sepsis that increases catecholamine and glucocorticoid secretion (as well as infusions of these hormones), early and high rates of IV lipid infusion that provide fatty acids to compete with glucose carbon for oxidation and also stimulate gluconeogenesis, and persistent hepatic glucose production that begins in utero in infants with growth restriction. There is no advantage to and many complications of higher dextrose infusion rates.

Key Points

- Although late preterm infants (born between e” 34 weeks and < 36 6/7 weeks gestation) may appear to be similar in size and appearance to term infants, they are at increased risk of complications.

NOTES

- Complications include hypothermia, hypoglycemia, poor feeding, excessive weight loss, respiratory distress, hyperbilirubinemia, and an increased likelihood of readmission after discharge.
- Treat disorders and support body temperature and feeding.
- Monitor neurodevelopmental status and provide appropriate referral to address any disabilities.

5.2.2 Nutrition for Low Birth Weight Infant

Low Birth Weight (LBW) remains a significant public health problem in many developing countries, and poor nutrition both before and during pregnancy is recognized as an important cause.

Emerging evidence on the role of intergenerational effects in determining maternal preconceptual nutritional status indicates the need for continued investment in strategies that improve women's nutrition and health throughout the life cycle, especially during the early years. Controlled trials have shown that improving food intakes during pregnancy effectively reduces LBW, but programs have been less successful because these interventions are expensive and difficult to manage.

Multivitamin-mineral supplements have been viewed as a simpler solution, but 2 of 3 controlled trials conducted to date failed to show that multivitamin-mineral supplements are more effective than are iron-folate supplements, which are already the standard of care during pregnancy.

Emerging evidence indicating the benefits of iron supplements in improving birth weight illustrate the need for increased efforts to reduce iron deficiency by improving coverage of antenatal programs and promoting fortification.

Other causes of LBW include environmental factors, such as smoking; indoor air pollution; and infections, such as malaria. However, little is known about the interactions between nutrition and infection.

Underlying social factors, such as poverty and women's status, are also important, especially in South Asia, where more than one-half of the world's LBW infants are born. In summary, strategies that combine nutrition-based interventions, such as improving food intakes and micronutrient status, especially iron status, with approaches that improve women's status and reproductive health are needed to reduce LBW.

Globally an estimated 20 million infants are born with Low Birth Weight (LBW), of those over 18 million are born in developing countries. These LBW infants are at a disproportionately higher risk of mortality, morbidity, poor growth, impaired psychomotor and cognitive development as immediate outcomes, and are also disadvantaged as adults due to their greater susceptibility to type 2 diabetes, hypertension and coronary heart disease.

NOTES

Malnutrition refers to deficiencies, excesses, or imbalances in a person's intake of energy and/or nutrients. Maternal malnutrition prior to and during pregnancy manifested by low bodyweight, short stature, inadequate energy intake during pregnancy and coexisting micronutrient deficiency are considered major determinants in developing countries where the burden is too high. LBW is a multifactorial outcome and its prevention requires a lifecycle approach and interventions must be continued for several generations. So far, most interventions are targeted during pregnancy primarily due to the increased nutritional demand and aggravations of already existing inadequacy in most women.

Several individually successful interventions during pregnancy include balanced protein energy supplementation, several single micro-nutrients or more recently a mix of multiple micronutrients. Nutrition education has been successful in increasing the dietary intake of pregnant women but has had no effect on LBW. The challenge is to identify a community-specific intervention package. Current evidence supports intervention during pregnancy with increased dietary intakes including promotions of foods rich in micronutrients and micronutrient supplementation, preferably with a multiple micronutrient mix.

Simultaneously, a culturally appropriate educational component is required to address misconceptions about diet during pregnancy and childbirth including support for healthy pregnancy with promotion of antenatal and perinatal care services. While further research is needed to identify more efficacious interventions, an urgent public health priority would be to select and implement an optimal mix of interventions to avert the immediate adverse consequences of LBW and to prevent the impending epidemic of type 2 diabetes, hypertension and coronary heart disease which are negatively associated with LBW.

WHO Recommendations

None of the recommendations below address sick infants or infants with birth weight less than 1.0 kg.

Feeding

- Low Birth Weight (LBW) infants, including those with Very Low Birth Weight (VLBW), should be fed mother's own milk.
- LBW infants, including those with VLBW, who cannot be fed mother's own milk should be fed donor human milk (recommendation relevant for settings where safe and affordable milk-banking facilities are available or can be set up).
- LBW infants, including those with VLBW, who cannot be fed mother's own milk or donor human milk should be fed standard infant formula (recommendation relevant for resource-limited settings).
- VLBW infants who cannot be fed mother's own milk or donor human milk should be given preterm infant formula if they fail to gain weight despite adequate feeding with standard infant formula.

NOTES

- LBW infants, including those with VLBW, who cannot be fed mother's own milk or donor human milk should be fed standard infant formula from the time of discharge until 6 months of age (recommendation relevant for resource-limited settings).
- VLBW infants who are fed mother's own milk or donor human milk should not routinely be given bovine milk-based human milk fortifier (recommendation relevant for resource-limited settings).
- VLBW infants who fail to gain weight despite adequate breast milk feeding should be given human-milk fortifiers, preferably those that are human milk based supplements.
- VLBW infants should be given vitamin D supplements at a dose ranging from 400 IU to 1000 IU per day until 6 months of age.
- VLBW infants who are fed mother's own milk or donor human milk should be given daily calcium (120–140 mg/kg per day) and phosphorus (60–90 mg/kg per day) supplementation during the first months of life.
- VLBW infants fed mother's own milk or donor human milk should be given 2–4 mg/kg per day iron supplementation starting at 2 weeks until 6 months of age.
- Daily oral vitamin A supplementation for LBW infants who are fed mother's own milk or donor human milk is not recommended at the present time, because there is not enough evidence of benefits to support such a recommendation.
- Routine zinc supplementation for LBW infants who are fed mother's own milk or donor human milk is not recommended at the present time, because there is not enough evidence of benefits to support such a recommendation.
- LBW infants who are able to breastfeed should be put to the breast as soon as possible after birth when they are clinically stable.
- VLBW infants should be given 10 ml/kg per day of enteral feeds, preferably expressed breast milk, starting from the first day of life, with the remaining fluid requirement met by intravenous fluids (recommendation relevant for resource-limited settings).
- LBW infants should be exclusively breastfed until 6 months of age.
- LBW infants who need to be fed by an alternative oral feeding method should be fed by cup (or palladai, which is a cup with a beak) or spoon.
- VLBW infants requiring intragastric tube feeding should be given bolus intermittent feeds.
- In VLBW infants who need to be given intragastric tube feeding, the intragastric tube may be placed either by oral or nasal route, depending upon the preferences of health-care providers.

- LBW infants who are fully or mostly fed by an alternative oral feeding method should be fed based on infants' hunger cues, except when the infant remains asleep beyond 3 hours since the last feed (recommendation relevant to settings with an adequate number of health-care providers).
- In VLBW infants who need to be fed by an alternative oral feeding method or given intragastric tube feeds, feed volumes can be increased by up to 30 ml/kg per day with careful monitoring for feed intolerance.

IU = international unit .These recommendations specifically address infants with birth weight between 1.0 and 1.5 kg.

References of Guidelines: WHO. Guidelines on optimal feeding of low birth-weight infants in low- and middle-income countries. Geneva, World Health Organization; 2011 (http://www.who.int/maternal_child_adolescent/documents/infant_feeding_low_bw/en/).

NOTES

5.2.3 Nutrition in Infants with Developmental Disabilities

Feeding is a physiology human process for nutrition which is influenced by social and cultural factors.

Children with developmental disabilities frequently develop problems with feeding that can lead to malnutrition and respiratory symptoms. Feeding disability is the consequence of multiple interacting variables that have disrupted feeding development and the feeding relationship. The pediatrician who has a solid understanding of these variables can understand the problems, sort out the contributing causes and intervene effectively.

Children with developmental disabilities are at high risk for malnutrition. Severe nutritional problems can be prevented through routine screening, timely assessment and appropriate intervention.

The need for a comprehensive nutritional assessment for the disabled child, presents nutritional intervention strategies for five problems common:

- Poor Growth and Failure to Thrive
- Overweight and Obesity
- Feeding Problems
- Constipation
- Drug-Nutrient Interactions

Children with cognitive and adaptive disabilities are at increased risk for developing feeding difficulties and secondary nutritional deficiencies. Problems, such as:

- Poor Oral-Motor Coordination
- Swallowing Dysfunction

- Gastroesophageal Reflux
- Aversive Feeding Behaviors

It comprise significant obstacles to growth, prevent the achievement of developmental potential, and threaten clinical stability.

NOTES

Feeding and nutritional problems in patients with developmental disabilities have been well documented, and malnutrition has been reported in up to 90% of nonambulatory children with cerebral palsy. Although diverse factors certainly contribute to this startling and disturbing observation, feeding disorders have been observed in a high percentage of children with major motor and cognitive disabilities. Failure to assess and treat these problems in a timely fashion not only hastens the onset of significant nutrient deficits, but also heightens the incidence of complications, increases hospitalization rates, and results in impaired quality of life.

Feeding Disorders

Feeding disorders represent major clinical problems that complicate the management of infants and children with neurodevelopmental disabilities. If left untreated, oral-motor, swallowing, and gastroesophageal function abnormalities lead to cachexia and poor growth, hinder developmental performance, and increase medical and behavioural morbidity. In the daily care of children with disabilities, parents and caregivers report difficult and prolonged feeding times that result in frustration and anger and often prevent the implementation of vital activities essential to the optimal management of developmental challenges, for example physical and occupational therapy, community programs, and recreational activities.

Classification of Feeding Disorders

An effective approach to managing feeding-associated problems depends upon the accurate determination of nutritional status and the correct identification of specific feeding disorders.

Functional motor disorders include problems of oral-motor coordination, swallowing and esophageal function. Difficulties with liquid and/or solid bolus formation, retrograde propulsion, and swallowing are delineated by the term *oropharyngeal dysphagia*. This descriptor encompasses oral-motor disorders, for example abnormalities in sucking, chewing, and lingual movement, swallowing discoordination (with or without laryngeal penetration leading to aspiration), and pharyngo-esophageal dyskinesia (impaired movement of the bolus into the esophagus).

GastroEsophageal Reflux (GER), which represents the cephalad propulsion of gastric contents into the esophagus or higher, is often associated with delayed esophageal acid clearance (accelerating the development of esophagitis) and prolonged gastric emptying time (exacerbating postprandial vomiting). GastroEsophageal Reflux (GER) may also manifest with laryngeal penetration of gastric contents and nasopharyngeal and tracheal aspiration.

Behavioural problems during feeding include food refusal, choking, gagging, or spitting unrelated to any specific neurological dysfunction, as well as sensory-based feeding problems (which usually involve textural aversions).

NOTES

Swallowing disorders
Oropharyngeal dysphagia
1. Poor bolus formation
   (a) thin liquids
   (b) thickened liquids
   (c) solids
2. Impaired retrograde propulsion
   (a) thin liquids
   (b) thickened liquids
   (c) solids
3. Laryngeal penetration
   (a) thin liquids
   (b) thickened liquids

Pharyngoesophageal dyskinesia

Esophageal disorders
Gastroesophageal reflux
Esophageal dysmotility
1. Apersistalsis (including achalasia)
2. Diffuse esophageal spasm
3. "Nutcracker" esophagus
4. Nonspecific motor abnormalities

Behavioral feeding disorders
Aversive feeding behaviors
Sensory-based feeding disorders

Modified from Schwarz et al. (2001).

Classification of Feeding Problems

Clinical Presentation of Feeding Disorders

In parallel with the diagnostic categories described above, individuals with disabilities who exhibit feeding and nutritional problems may also be subdivided into 2 broad clinical groups.

The first clinical category encompasses patients who demonstrate major motor dysfunction (often associated with cognitive deficits), and the most prevalent diagnoses in this group are cerebral palsy and mental retardation.

Nutritional deficiencies in these patients are commonly associated with poor oral-motor coordination, swallowing dysfunction, and GER. Overall, oropharyngeal dysphagia and GER represent the most common feeding-related problems. Typical symptoms that suggest oral-motor and swallowing difficulties include excessive drooling leading to ineffective feedings with prolonged meal times.

NOTES

Coughing or gagging during meals, especially with liquids, suggest oral-motor difficulties; and these symptoms may indicate GER if they are more severe at night, in the early morning, or during the postprandial period. Postprandial vomiting is the most typical sign of GER during infancy and early childhood; however, feeding-associated irritability or chest pain (in older children who are capable of verbalizing pain) secondary to gastric acid-induced dyspepsia or esophagitis is a common finding. In its most severe form, this symptom of GER may present as Sandifer's syndrome, a triad of back arching, neck extension, and head deviation to one side (often misdiagnosed as athetosis, spastic torticollis, or even seizures).

- Disorders of oral-motor and swallowing function
  - Choking/gagging during feeding
  - Excessive drooling
  - Prolonged feeding times
  - Recurrent pneumonia
  - Malnutrition/growth failure
- Gastroesophageal reflux
  - Recurrent vomiting
  - Dysphagia or feeding refusal (vomiting and irritability during infancy)
  - Apnea (infancy)
  - Asthma
  - Recurrent pneumonia
  - Upper airway symptoms
  - Esophagitis (heartburn, chest pain, upper gastrointestinal tract bleeding)
  - Malnutrition/growth failure

Clinical Presentation of Swallowing Disorders and Gastroesophageal Reflux

Additional complications that are associated with these feeding disorders include malnutrition as a result of inadequate energy intake, aspiration (from above, secondary to swallowing dysfunction or from below, because of GER), and problems related to esophagitis, such as upper gastrointestinal tract bleeding and esophageal stricture formation.

GER-related reactive airway disease may develop secondary to the microaspiration of gastric contents. However, tracheopulmonary aspiration of acid may not be required to elicit altered pulmonary function. Experimental data in an animal model indicate that an esophageal, chemoreceptor-mediated reflexive increase in airway resistance may result from GER, i.e., reflux without aspiration.

Children in the second major diagnostic group of disabilities (including the diagnoses of autism and pervasive developmental delay) usually exhibit minor or

no gross motor deficits. Feeding and nutritional problems in these patients are often the consequences of behavioural food refusal or sensory-based textural aversions. Nevertheless, a careful history in children with apparent behavioural feeding problems often demonstrates a prior history or current complaint of gastrointestinal symptoms, for example vomiting, feeding-associated irritability during infancy, abdominal/chest pain that suggest a diagnosis of GER.

NOTES

Diagnosis and Management of Feeding Disorders

In children with disabilities, feeding difficulties that commence during infancy are associated with growth failure and predict adverse developmental outcomes. Early evaluation, diagnosis, and nutritional intervention may avoid secondary feeding-associated complications and maximize growth potential. For example, in one study of 51 children with cerebral palsy, the linear growth responses to supplemental tube feedings were greatest when nutritional intervention commenced within 6 months of the primary neurological insult. Conversely, when nutritional rehabilitation was delayed until 8 years of age, linear growth rates lagged behind expected levels, although significant weight gain was achieved. Such chronic undernutrition is often viewed as benign neglect and this attitude is often the greatest obstacle to nutritional success for children with developmental disabilities.

Malnutrition in children with primary neurological impairment arises insidiously and progresses over time. Therefore, assessments of diet and nutritional status in at-risk patients should be carried out by the primary care provider monthly during the first year of life and at least yearly thereafter. Interval histories address the duration of mealtimes, feeding-related symptoms, and, in toddlers and older children, any specific food aversions (other than the expected, age-related food preferences and dislikes seen in children without disabilities). Once a feeding disorder is suspected, an aggressive diagnostic and therapeutic program will offer the greatest likelihood for successful management. A multidisciplinary team approach involves physicians, nutritionists, feeding therapists, speech-language pathologists, and parents/guardians, in order to increase the potential for improved clinical outcomes.

Clinical Assessment of Nutritional Status

In general, the severity of malnutrition in children with developmental disabilities correlates closely with their degree of neurodevelopmental impairment. The most severely compromised patients are nonambulatory and they exhibit varying degrees of spasticity associated with either diplegia or quadriplegia. Clinical assessments often demonstrate inadequate subcutaneous tissue stores and evidence of chronic malnutrition. On the other hand, non-ambulatory patients who retain normal swallowing and upper gastrointestinal function are at increased risk for developing obesity, because of reduced total energy expenditure. Careful records of linear growth, weight gain, and head circumference, plotted on appropriate growth charts will provide critical information regarding overall nutritional status. However, the accurate assessment of stature may be difficult in children with severe

disabilities. For children with cerebral palsy, whose linear measurements cannot be made by standard techniques, segmental measures of knee height or tibial length may be utilized. Estimates of stature can then be calculated and plotted on standard growth charts.

NOTES

The nutritional evaluation of pediatric patients, and to distinguish between acute and chronic malnourished states, the Waterlow classification of malnutrition and growth failure has also proven useful in the nutritional assessment of neurodevelopmental disorders.

Utilizing this methodology, patients are classified according to their measured grade of malnutrition (% expected weight for height) and growth retardation (% expected height for age).

Measurements of triceps and subscapular skin-fold thicknesses may be used to estimate fat and lean body mass, in order to determine body composition and gauge the outcomes of management.

Calculation of the Body Mass Index (BMI) also provides useful information, particularly for non-ambulatory individuals who retain normal swallowing and gastroesophageal function, and for children with feeding and swallowing disorders following Gastrostomy Tube (GT) placement. In these situations, the risk of emerging obesity presents another nutritional challenge, either as a consequence of reduced energy expenditure (non-ambulatory patients without functional motor feeding problems), or in tube-fed patients where aggressive nutritional rehabilitation may provide energy intake that exceeds requirements. Additional laboratory screening studies should include circulating micronutrient levels, especially calcium, phosphorous, and vitamin D, and Thyroid Function Studies (T_4, TSH). Recent studies indicate that vitamin and mineral intake is inadequate in non-ambulatory subjects, and resulting deficiencies contribute to the development of osteopenia and pathological fractures.

Step-Up Therapy of GER

GER is a common problem in children with neurodevelopmental disabilities, its medical management deserves more detailed consideration. Furthermore, GER therapy has undergone significant changes over the past several years. Conservative measures are useful in the management of mild to moderate reflux, in the absence of significant oral-motor difficulties.

Generally, recommendations of thickening formula with 1 tablespoon of rice cereal per each 2 ounce of formula, while reducing volumes by 1 to 2 ounce per feeding and increasing feeding frequency. This technique has been shown to ameliorate GER episodes, and formula thickening does not prolong gastric emptying time. Because the symptoms of dietary protein intolerance can sometimes mimic those of GER and exacerbate existing reflux, a trial of a hypoallergenic formula may be considered. In older children and adolescents with disabilities, smaller and

more frequent meals and maintaining an upright position after meals are recommended. Previous studies demonstrated reduced frequency and severity of GER with prone positioning of infants following feeding and during sleep. However, because of the increased incidence of Sudden Infant Death Syndrome (SIDS) associated with the prone sleep position. Although not well studied in older children, the adult experience suggests that the left-sided sleep position and elevation of the head of the bed may be useful.

Determining Nutritional Requirements

Diagnosis-specific interventions will limit the occurrence of feeding-associated complications and offer the greatest opportunity to achieve nutritional rehabilitation for children with disabilities. However, optimal long-term management depends upon accurately determining nutritional requirements. Conventional formulas for calculating energy expenditure include the Harris-Benedict and World Health Organization equations. In clinical practice, we often use the following calculations for estimating energy requirements:

100 Kcal/kg, for each kg body weight 1-10

50 Kcal/kg, for each kg body weight 11-20

20 Kcal/kg, for each kg body weight > 20

These equations are based upon data derived from energy expenditure determinations for hospitalized patients without chronic disabilities. For non-ambulatory subjects, including those with neurodevelopmental disabilities, these calculations often overestimate energy requirements. For example, mean total energy expenditure in quadriplegic children is significantly lower when compared with normal controls; and energy expenditure is also lower in adequately nourished quadriplegic children than in poorly nourished subjects with similar disabilities. Factors, such as chronically inadequate calorie intake and physical immobility contribute to reduced energy requirements in the most severely impaired, non-ambulatory patients. These problems may be even more complex in nutritionally growth stunted children, where endogenous fat oxidation is impaired. As stated above, reduced steady-state energy expenditure of growth impaired, non-ambulatory children may actually increase the likelihood of obesity, under conditions where swallowing function is preserved or after GT feedings have been instituted.

To account for the unique problems related to estimating nutritional requirements in non-ambulatory subjects, prior studies have proposed modified calculations of energy requirements. Corrected estimates of basal metabolic rates or the Recommended Daily Allowance (RDA) for energy intake consider factors, such as muscle tone, movement, and activity to determine requirements for non-ambulatory patients. Newer equations for predicting energy expenditure, based upon estimates of fat-free body mass derived from skin-fold thickness measurements, have recently been validated in a group of adolescent and adult

subjects. In these nonambulatory patients, Resting Energy Expenditure (REE) is defined by the equation:

$$REE = 22.3 \times FFM - 9.4A + 557$$

NOTES

Where,

FFM is Fat-Free Body Mass

A is age in years

This equation proves to be highly predictive and unbiased in the determination of mean REE for adolescents and adults in the most severely disabled, quadriplegic group. However, this formula has not yet been evaluated in a younger pediatric population. When assessing energy expenditure calculations for pediatric patients, problems of growth and physical development must also be considered. Furthermore catch-up growth, where feasible, must be supported in chronically undernourished children. Future studies will need to address these important issues, before recommending a standard equation that defines energy expenditure in disabled children (if, indeed, a single equation is applicable).

In addition to improving nutritional status, management objectives in treating children exhibiting feeding disorders include:

- Preventing complications secondary to oral-motor dysphagia and GER.
- Maximizing the overall level of patient function.
- Decreasing the costs of care. Regardless of diagnosis, nutritional needs in motor and cognitively impaired children can be adequately met only in patients who receive comprehensive, multidisciplinary services.

For children with cerebral palsy and oral-motor dysfunction, caregiver interview data suggest that tube feedings improve quality of life indicators, both for the child and for the family.

Investigations of adult subjects with disabilities indicate that strategies aimed at reducing complications from swallowing disorders may be life sustaining. In one report, unadjusted Kaplan-Meier survival curves for institutionalized patients with feeding tubes demonstrated a significantly lower 2 year mortality when compared to subjects without feeding tubes. No therapy, however, is immune from associated complications. Late G-Tube (GT) problems include extruded or buried tubes, gastric metaplasia adjacent to the GT site, and gastric mucosal ulceration. However, when GT feedings are indicated, our experience demonstrates that the benefits gained from achieving adequate nutrition, including delaying or possibly obviating the need for anti-reflux surgery, far outweigh the potential risks from long-term GT placement.

Malnutrition in non-ambulatory patients with disabilities is often associated with complications that increase morbidity, such as decubiti, osteopenia, and other nutrient deficiencies. These problems, as well as problems related to oropharyngeal dysphagia and GER, including aspiration pneumonia, hypoxemia during feedings,

and reactive airway disease, significantly increase acute-care hospitalization rates and the costs of care. In our recent study, the acute-care hospitalization rate significantly fell, from 0.4 hospital admissions per patient-year in the 2 years prior to feeding/nutritional intervention, to 0.15 admissions per patient-year following institution of therapy height. Based upon an average length of stay of approximately 5 days for all children admitted to our hospital (frequently longer for children with disabilities), at least 180 hospital days were saved over 2 years for this group of 79 children. Accordingly, prompt and appropriate management of feeding disorders in children with neurodevelopmental disabilities not only enhances clinical outcomes and improves quality of life measures, but also reduces the financial burdens associated with repeated and prolonged hospitalizations on families, health care providers, and institutions. Historically, individuals with severe developmental disabilities and chronic medical conditions have been among the greatest consumers of health care. At a time when all caregivers (families, physicians, nurses, home care professionals) are struggling with diminishing resources for health, community, and educational services, the importance of reducing costs of care while improving clinical outcomes and quality of life cannot be overemphasized. Without attention to nutrition and the combination of medical, developmental, and family supports, children with these challenges will have frequent absences from their daily routine activities, increase their need for hospital services, and not be able to fully participate in community and educational activities.

Feeding Disorders in Children with Developmental Disabilities

It is observed that children with cognitive and adaptive disabilities may show concerns with feeding as well as nutritional deficits. A neurological disability is associated with oral-motor dysfunction along with swallowing disorders and GER.

- Sensory as well as behavioural aversions to food are associated in children on the spectrum of autism or pervasive developmental delay.
- Infants and children with developmental disabilities require feeding and nutritional assessments to be conducted every month for the first year of life and annually thereafter.
- A multidisciplinary team approach involving pediatricians, parents or caregivers, nutrition specialists and speech-language pathologists.

Children with GER

- Medical therapy plus nutritional rehabilitation may decrease the severity of GER, thus avoiding (or postponing) anti-reflux surgery.
- Recurrent pneumonia and severe esophagitis and unresponsive to medical therapy are the most common indications for surgical GER correction.
- For children with oral-motor and swallowing disorders:
- GT insertion is indicated when aspiration of both thin and thickened liquids is demonstrated.

- Nutritional rehabilitation following GT placement may lead to improved swallowing function and permit reestablishment of some oral feedings.
- Diagnosis-specific management of feeding disorders leads to improved nutrition, fewer clinical complications, and better quality of life for patients and caregivers.

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Check Your Progress

1. In how many weeks is a preterm baby born?
2. How are preterm birth categorized?
3. What are the maternal causes of preterm birth?
4. What is IV feeding?
5. Define the term feeding.
6. How can nutritional problems be prevented in children?
7. What does feeding disorders represent?
8. How is nutritional status improved in children?

5.3 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. A baby born preterm is delivered before 37 weeks of pregnancy are completed.
2. The preterm birth is categorized based on gestational age:
   - Extremely preterm (less than 28 weeks)
   - Very preterm (28 to 32 weeks)
   - Moderate to Late Preterm (32 to 37 weeks)
3. Known maternal causes of preterm birth include:
   - Multiple pregnancies
   - Infections
   - Chronic conditions, such as diabetes and high blood pressure
   - Genetic influence
4. IV feeding, including amino acids is generally started right after birth at rates that are appropriate for the gestational age of the infant. The IV nutrition is fundamental in all infants who cannot tolerate full enteral feedings. Metabolic and thus nutritional requirements do not stop with birth; this includes protein accretion. IV feeding is always indicated when normal metabolic needs are not met by normal enteral feeding.

5. Feeding is a physiology human process for nutrition which is influenced by social and cultural factors.
6. Children with developmental disabilities are at high risk for malnutrition. Severe nutritional problems can be prevented through routine screening, timely assessment and appropriate intervention.
7. Feeding disorders represent major clinical problems that complicate the management of infants and children with neurodevelopmental disabilities.
8. In addition to improve nutritional status, management objectives in treating children exhibiting feeding disorders include:
   - Preventing complications secondary to oral-motor dysphagia and GER.
   - Maximizing the overall level of patient function.
   - Decreasing the costs of care. Regardless of diagnosis, nutritional needs in motor and cognitively impaired children can be adequately met only in patients who receive comprehensive, multidisciplinary services.

5.4 SUMMARY

- A baby born before the 37th week is known as a premature or preterm baby.
- A preterm birth may happen spontaneously, but some births are probably due to early induction of labour or caesarean birth, whether for medical or non-medical reasons.
- The premature infant is petite and generally weighs less than 2.5 kg.
- Monitoring infant's progress and frequent weight assessments are necessary to optimize growth and nutrition in preterm infants.
- The infant's weight, length, and head circumference is assessed weekly and plotted on an appropriate growth chart.
- In the first week of an infant protein and energy intakes are associated with 18-month developmental outcomes even in Extremely Low Birth Weight (ELBW), extremely preterm infants.
- Reasons for failure to provide sufficient nutrition to preterm infants are many, including a delayed start to providing nutrients, for example low or no IV amino acids on day 1 and enteral feedings often are held, sometimes for days; the amount of nutrient supplies are low.
- The medical management to optimize the benefits of enhanced and improved nutrition in very preterm infant's right after birth.
- Preterm infants have to be monitored clinically as their physiology after birth needs attention.
- Clinical manifestations indicate that preterm babies have low and high oxygen concentrations.

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- IV feeding, including amino acids is generally started right after birth at rates that are appropriate for the gestational age of the infant.
- The smaller the infant, the less body stores like protein, fat, and glycogen are available to provide nutrients for metabolic needs.
- Low glucose values (hypoglycemia) are less common in preterm infants due to early and relatively high rates of IV dextrose infusions.
- Low Birth Weight (LBW) remains a significant public health problem in many developing countries, and poor nutrition both before and during pregnancy is recognized as an important cause.
- Other causes of LBW include environmental factors, such as smoking; indoor air pollution; and infections, such as malaria.
- Globally an estimated 20 million infants are born with Low Birth Weight (LBW), of those over 18 million are born in developing countries.
- LBW infants are at a disproportionately higher risk of mortality, morbidity, poor growth, impaired psychomotor and cognitive development as immediate outcomes, and are also disadvantaged as adults due to their greater susceptibility to type 2 diabetes, hypertension and coronary heart disease.
- Maternal malnutrition prior to and during pregnancy manifested by low bodyweight, short stature, inadequate energy intake during pregnancy and coexisting micronutrient deficiency are considered major determinants in developing countries where the burden is too high.
- LBW is a multifactorial outcome and its prevention requires a lifecycle approach and interventions must be continued for several generations.
- Feeding is a physiology human process for nutrition which is influenced by social and cultural factors.
- Children with developmental disabilities frequently develop problems with feeding that can lead to malnutrition and respiratory symptoms.
- Feeding disability is the consequence of multiple interacting variables that have disrupted feeding development and the feeding relationship.
- The pediatrician who has a solid understanding of these variables can understand the problems, sort out the contributing causes and intervene effectively.
- Children with developmental disabilities are at high risk for malnutrition. Severe nutritional problems can be prevented through routine screening, timely assessment and appropriate intervention.
- Children with cognitive and adaptive disabilities are at increased risk for developing feeding difficulties and secondary nutritional deficiencies.

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- Feeding disorders represent major clinical problems that complicate the management of infants and children with neurodevelopmental disabilities.
- Functional motor disorders include problems of oral-motor coordination, swallowing and esophageal function.
- Additional complications that are associated with these feeding disorders include malnutrition as a result of inadequate energy intake, aspiration, and problems related to esophagitis, such as upper gastrointestinal tract bleeding and esophageal stricture formation.
- Malnutrition in children with primary neurological impairment arises insidiously and progresses over time.
- The nutritional evaluation of pediatric patients, and to distinguish between acute and chronic malnourished states, the Waterlow classification of malnutrition and growth failure has also proven useful in the nutritional assessment of neurodevelopmental disorders.

5.5 KEY WORDS

- **Preterm baby:** A baby born before the 37^{th} week is known as a premature or preterm baby.
- **Feeding**: Feeding is a physiology human process for nutrition which is influenced by social and cultural factors.
- **Malnutrition:** Malnutrition refers to deficiencies, excesses, or imbalances in a person's intake of energy and/or nutrients.

5.6 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. How is nutrition managed in children?
2. What does the physical perception of the child indicates?
3. How is IV feeding done?
4. Write a brief note on feeding disorder.
5. How is feeding disorder managed and diagnosed?
6. What are the feeding disorders in children with developmental disabilities?

Long-Answer Questions

1. Discuss about nutritional management of premature baby.
2. Explain how nutrition management plays an important role in care of preterm infant.

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3. Describe about IV dextrose (glucose) infusion.
4. Discuss about nutrition for low birth weight infants.
5. Explain in detail about how nutrition in infants with developmental disabilities managed.
6. Write a descriptive note on classification of feeding disorders and feeding problems.
7. Analyse the clinical presentation of swallowing disorders and gastroesophageal reflux.
8. Explain how nutritional requirements are managed in children.

5.7 FURTHER READINGS

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UNIT 6 INFANT LACTATION

NOTES

Structure

6.0 Introduction
6.1 Objectives
6.2 Infant Lactation its Characteristics, Causes and Complications
  6.2.1 Characteristics of Breastfeeding
  6.2.2 Causes and Complications of Breastfeeding
6.3 Growth and Nutritional Assessment of Infant's Lactation and their Feeding Methods
  6.3.1 Breastfeeding Methods: Rectified and Improvisations
6.4 Answers to Check Your Progress Questions
6.5 Summary
6.6 Key Words
6.7 Self Assessment Questions and Exercises
6.8 Further Readings

6.0 INTRODUCTION

Breastfeeding is when a mother feeds her baby breast milk, usually directly from her breast. It is also called nursing. Normally, the natural production of breast milk, i.e., lactation is triggered by a complex interaction between three hormones, i.e., estrogen, progesterone and human placental lactogen during the final months of pregnancy. At delivery, levels of estrogen and progesterone fall, allowing the hormone prolactin to increase and initiate milk production.

Breast milk provides the ideal nutrition for infants. It has a nearly perfect mix of vitamins, protein, and fat everything a baby needs to grow. It is all provided in a form that is more easily digestible as compared to infant formula. Breast milk contains antibodies that help the baby fight against viruses and bacteria. Breastfeeding lowers the baby's risk of having asthma or allergies. Plus, babies who are breastfed exclusively for the first 6 months, without any formula, have fewer ear infections, respiratory illnesses and bouts of diarrhea. They also have fewer hospitalizations and trips to the doctor.

Breastfeeding burns extra calories, so it can help lose pregnancy weight faster. It releases the hormone oxytocin, which helps your uterus return to its pre-pregnancy size and may reduce uterine bleeding after birth. Breastfeeding also lowers your risk of breast and ovarian cancer. It may lower the risk of osteoporosis, too.

New mothers may experience nursing problems like engorgement in which breasts that are too full and prevent the baby from suckling because they cannot be grasped. Expressing milk manually or with a breast pump can alleviate this

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problem. Transient soreness can occur during the first week postpartum and is usually temporary. Air drying the nipples and rubbing colostrum or breast milk into them provides relief. Prolonged, abnormal soreness lasts longer than a week postpartum. Discontinuing use of soap on breasts while bathing and applying purified lanolin to nipples and air drying them helps. Soreness and inflammation on the breast surface or a fever in the mother may be an indication of breast infection, i.e., mastitis. If it is just starting, the mother should drink lots of water and nurse frequently on the affected breast. Antibiotics may be necessary if the infection persists.

In this unit, you will study about infant lactation, its characteristics, causes and complications, feeding methods, growth and nutritional assessment of infant's lactation.

6.1 OBJECTIVES

After going through this unit, you will be able to:

- Understand about infant lactation
- Discuss the characteristics, causes and complications of infant lactation
- Analyse various feeding methods
- Describe the growth and nutritional assessment of infant's lactation

6.2 INFANT LACTATION ITS CHARACTERISTICS, CAUSES AND COMPLICATIONS

Lactation is natural process of feeding the infant with breast milk. The physiology of lactation involves the pituitary gland hormones - prolactin and oxytocin that are required to maintain milk secretion. The hormone prolactin maintains synthesis of milk products while oxytocin stimulates the letdown response that allows the infant to extract milk from the gland.

Breast feeding is a sure medium to ensure child health and survival. We all have known that breast milk is the only ideal food for infants below one year of age.

- Lactation is safe and clean wherein the breast milk contains antibodies known to provide protection against common childhood illnesses.
- Breast milk provides all the energy and nutrients that the infant needs for the first months of life, and it continues to provide up to half or more of a child's nutritional needs during the second half of the first year, and up to one third during the second year of life.
- Breastfed children perform better on intelligence tests that are less likely to be overweight or obese and less prone to diabetes later in life.

- The benefit to women is that those who are breastfeed will also have a reduced risk of breast and ovarian cancers in future.

The recommendation from WHO and UNICEF is that infants should be initiated with breast milk within the first hour of birth and be exclusively breastfed for the first 6 months and no other foods or liquids to be provided to the infant and not even water. As per pediatricians suggestions that:

- The infants should be breastfed on demand that is as often as the child is hungry and cries for feed.
- Use of bottles, teats or pacifiers is discouraged.
- It is advisable that from the age of 6 months the infants should be fed on hygienic, safe and adequate complementary foods while continuing to breastfeed for up to 2 years and beyond if possible.
- Breast milk is essential for energy and nutrients during illness and reduces infection among children with malnourishment.
- Research studies indicate that infant's breastfed are less likely to be overweight or obese as adolescents.
- Moreover, these children cognitively perform better on intelligence tests and have appreciable school attendance.

As the primary 2 years of an infant's life are important, it is the optimum nutrition during this phase that shall help lower chances of infection and reduce the chances of chronic disease that fosters overall wellbeing.

6.2.1 Characteristics of Breastfeeding

It is observed that 50 percent of the women make consider breast milk as a feeding option even prior to their conception, while the some may make the decision only during their initial pregnancy. According to maternal and neonatal health advocates the importance of early prenatal care is also to initiate a positive open conversation about breastfeeding with the pregnant mother and her family.

It has been observed that during prenatal session pregnant women often abate breastfeeding counseling deferring it until later visits. Observational evidence is suggestive of the fact that many gestational women are actually unaware and blindsided by issues encountered during breastfeeding thereby it is suggestive that earlier breastfeeding conversations may actually facilitate enhanced breastfeeding preparation, confidence, and success. Breastfeeding discussions during the initial prenatal visit may be even more critical in practices serving uninsured and minority populations, as these patients are at risk for inconsistent prenatal care.

We acknowledge that prenatal breastfeeding sessions with pregnant women will increase their awareness on breastfeeding initiation, exclusivity, and duration of lactation.

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In a study conducted by Pitts A, Faucher MA, Spencer R. Incorporating breastfeeding education into prenatal care, 23 women had participated, 21 women had completed questionnaires at 6 weeks of postpartum. All these 21 women answered the content questions at the end of the modules correctly.

- 67 % reported prior breastfeeding experience.
- 95% initiated breastfeeding.
- 86% were exclusively breastfeeding at 6 weeks postpartum.
- 71% of the women planned to exclusively breastfeed for 6 months.
- 67 % reported the modules promoted or affirmed their decision to breastfeed.
- 5% would have preferred group-based education.

The observations made by researchers confirmed that prenatal breastfeeding education, in a clinical/medical setting will be a welcome norm appreciated by pregnant women and breastfeeding education information should be imparted during gestation.

Sociocultural and community factors influencing the medical maternity setting may have a detrimental effect on timely initiation as the first breastfeed within first hour after birth, along with exclusive breastfeeding.

Timely initiation and exclusive breast feeding facilitators were:

The information about breastfeeding and infant feeding practices that the mothers was offered during pregnancy, early or 1 month postpartum, support either from health professionals or their family members, and the mother's previous experience with breastfeeding.

The main barriers for timely initiation are as follows:

- The maternal and child hospital care practices.
- The use of infant formula to feed newborns.
- The breast milk substitutes promotion within the hospital.
- The lack of support to women to initiate breastfeeding.
- Birth by cesarean section or complicated delivery.
- The mother's beliefs and perceptions about milk insufficiency.
- The assistance offered for difficulties faced during breastfeeding such as sore/cracked nipples.
- The recommendation of breast milk substitutes use by health personnel and family members, were identified as barriers.

The importance of breastfeeding in low-income and middle-income countries is being acknowledged but fewer consensuses exist about its importance in high-income countries is as follows:

- 37% of children younger than 6 months of age are exclusively breastfed in the low-income and middle-income countries.

- Breastfeeding duration is shorter in high-income countries than in those that are resource-poor.

Although the established benefits breastfeeding are globally accepted but it may seem that breastfeeding is no longer a norm in many communities. The determinants of breastfeeding need supportive measures at many levels inclusive of legal along with policy directives to social attitudes and values, women's work and employment conditions, and health-care services to enable women to breastfeed.

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6.2.2 Causes and Complications of Breastfeeding

Following are the causes and complications of breastfeeding:

Inadequate Milk Intake

The common reason for a mother to stop breastfeeding is inadequate milk supply.

Inadequate Milk Production

There are a number of reasons why a mother might not make enough milk, including:

- Underdeveloped breast development sufficiently during pregnancy hence not having enough milk-producing tissue which is the glandular tissue.
- Mother's previous breast surgery or radiation treatment.
- A hormonal imbalance in the mother.
- Certain medications that interfere with milk production in the mother.

Poor Extraction of Milk

The possible reason for infant not getting enough milk can be:

- Frequent feeding that can cause milk production to slow or stop.
- Poor breast latch.
- Child separated from mother for long hours.
- Feeding formula.

During the first few days after birth the babies are generally sleepy and probably this prevents the baby from getting enough milk feed from lactation.

Few babies may have weak control of the muscles involved in suckling, which makes it a bit of a task for them to extract milk. It is observed that feeding is very difficult naturally among premature and late preterm babies.

Most times the mother may judge the adequacy of feeding by frequency of crying. This can be misleading if the baby is not getting enough milk and is overly sleepy.

Importance of Lactation

Breastfeeding for 6 months is beneficial for both the infant and mother. The main benefit is the protection against gastrointestinal infections due to early initiation of breastfeeding which is within 1 hour of birth, protects the newborn from acquiring

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infections and reduces newborn mortality. There is a known risk of mortality because of diarrhea and other infections can increase in infants who are either partially breastfed or not breastfed at all.

Breast milk is very important source of energy and nutrients in infants: age 6 months to 24 months, providing:

- 50 % of a child's energy needs between the ages of 6 and 12 months.
- 25% of energy needs between 12 and 24 months.

Breast milk is essential for energy and nutrients during illness and reduces infection among children with malnourishment.

It is quoted in various studies that infants breastfed are less likely to be overweight or obese as adolescents. Additionally, these children cognitively perform better on intelligence tests and have appreciable school attendance.

Pediatric health experts claim those mothers with longer durations of lactation benefit with health and well-being as breastfeeding reduces the risk of ovarian and breast cancer.

Breastfeeding allows spacing between pregnancies as exclusive breastfeeding of babies under the age of 6 months has a hormonal effect which often induces a lack of menstruation. Gynecologists warn that the natural conception is not fail-safe method of birth control known as the Lactation Amenorrhoea Method.

It is advised to mother's that as the infant reaches the age of 6 months, the need for energy and nutrients starts to increase and complementary foods are initiated to meet those needs. The infant's gut of this age is also developmentally ready for other foods and any delay in complementary foods are not introduced around the age of 6 months, or if they are given inappropriately, an infant's growth may hinder. Lactation is still continued frequently and on-demand breastfeeding is encouraged until 2 years of age or beyond supplemented with weaning foods.

Problems in Lactation

Families in unprecedented circumstances require special attention and practical support for encouraging lactation. It is recommended that mother and baby should remain together and get the necessary support that they need to exercise the most appropriate feeding option available.

Breastfeeding in difficult situations can be difficult if situations arise, such as:

- Low-birth-weight or premature infants.
- The mother suffering from COVID/ HIV/Cancer/ Tuberculosis.
- Adolescent mothers.
- Infant born to an undernourished mother.
- Caesarian delivery.
- Families suffering the consequences of complex emergencies.

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HIV and Infant Feeding

Breastfeeding and especially early and exclusive breastfeeding, is one of the most significant ways to improve infant survival rates. The evidence on research shows that Antiretroviral Treatment (ART) given to mothers living with HIV significantly reduces the risk of transmission of HIV through breastfeeding to the infant while also improves her health.

WHO recommendation is individual's inclusively pregnant women and lactating mothers living with HIV; take ART for life upon confirmation of infection status.

Breast Milk Composition

Mother's breast milk contains all the nutrients that an infant needs in the first 6 months of life inclusive of fat, carbohydrates, proteins, vitamins, minerals and water. The breast milk is easily digested by the infant and efficiently utilized by the gut. Scientific studies show that breast milk also contains bioactive factors that augment the infant's immature immune system, providing protection against infection, and other factors that help digestion and absorption of nutrients.

Carbohydrate

The carbohydrate in the breast milk is:

- Lactose, a disaccharide - 7 g lactose per 100 ml.
- Oligosaccharides, sugar chains, which provide important protection against infection.

Fats

Breast milk provides about one half of the energy content of the milk contains about 3.5 g of fat per 100 ml of milk. The fat in the breast milk is secreted in droplets and the amount increases as the breast feeding progresses. The hindmilk which is secreted towards the end of a feed is rich in fat and is creamy white, whereas the foremilk at the beginning of a feed contains less fat and may seem bluish-grey in colour.

Beneficial component on Breast milk fat is the presence of long chain polyunsaturated fatty acids (Docosahexaenoic Acid or DHA, and Arachidonic Acid or ARA) which is not available to the infant from consumption of any other milk. The fatty acids are an important constituent for the neurological development of a child. DHA and ARA may be added to some varieties of infant formula, but this does not confer any advantage over breast milk, and may not be as effective as those in breast milk.

Protein

Breast milk protein differs in both quantity and quality from animal milks, and it contains a balance of amino acids which makes it much more suitable for a baby. The concentration of protein in breast milk (0.9 g per 100 ml) is lower than in animal milks. The much higher protein in animal milks can overload the infant's

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immature kidneys with waste nitrogen products. Breast milk contains less of the protein casein, and this casein in breast milk has a different molecular structure. It forms much softer, more easily-digested curds than that in other milks. Among the whey, or soluble proteins, human milk contains more alpha-lactalbumin; cow milk contains beta-lactoglobulin, which is absent from human milk and to which infants can become intolerant.

Vitamins and Minerals

Incase of a healthy mother with no deficiencies the breast milk normally contains sufficient vitamins for an infant with the exception is vitamin D. The infant will need skin exposure to sunlight to generate endogenous vitamin D in the body but if this is not possible, a supplement is given. The minerals like iron and zinc are present in relatively low concentration, but their bioavailability and absorption is high. Provided that maternal iron status is adequate, term infants are born with a store of iron to supply their needs; only infants born with low birth weight may need supplements before 6 months. Delaying clamping of the cord until pulsations have stopped (approximately 3 minutes) has been shown to improve the infants iron status during the first 6 months of life.

Anti-Infective Factors

Breast milk contains many factors that help to protect an infant against infection including:

- Immunoglobulin: Principally secretory immunoglobulin A (sIgA). Coats the intestinal mucosa and prevents bacteria from entering the cells.
- White blood cells: Kills microorganisms.
- Whey proteins (lysozyme and lactoferrin): Kills bacteria, viruses and fungi.
- Oligosaccharides: Prevent bacteria from attaching to mucosal surfaces.

These protection provided by the above factors is uniquely valuable for an infant to provide immunity.

Assessment of Infant's Lactation

Reflexes in the baby: The baby's reflexes- rooting, suckling and swallowing are important for appropriate breastfeeding. Supporting a mother as well as a baby to initiate to establish exclusive breastfeeding is essential to know about these reflexes, as their level of maturation will assist breastfeeding directly or temporarily figure out another feeding method.

How a Baby Attaches and Suckles at the Breast

Good Attachment/ Latching

A good latching shows: Most of the areola and the tissues underneath it are in the baby's mouth with the breast completely stretched out to form a long teat wherein the nipple only forms about one third of the teat. The baby's tongue is forward over the lower gums, beneath the milk ducts and the baby is suckling from the

breast, not from the nipple. As the baby suckles, a wave passes along the tongue from front to back, pressing the teat against the hard palate, and pressing milk out of the sinuses into the baby's mouth from where he or she swallows it. The baby uses suction mainly to stretch out the breast tissue and to hold it in his or her mouth. The oxytocin reflex makes the breast milk flow along the ducts, and this action of the baby's tongue presses the milk from the ducts into the baby's mouth. When a baby is well attached his mouth and tongue do not rub or traumatise the skin of the nipple and areola. A good latching ensures that suckling is comfortable without pain.

Poor Attachment

Poor attachment inside the infant's mouth shows the nipple is in the baby's mouth, not the underlying breast tissue or ducts (Refer Figure 6.1). The baby's tongue is back inside his or her mouth, and cannot reach the ducts to press on them. Suckling with poor latching will not only be uncomfortable for the mother but may cause sore nipples and fissures on the breasts. In case of poor latching the attachment needs to be improved to make lactation comfortable.

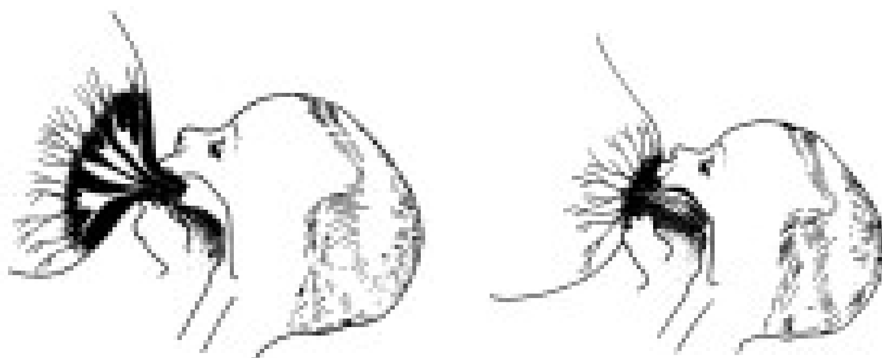


Fig. 6.1 *Baby Not Well Attached at the Breast*

Good Latching Ensures Successful Lactation

Signs of Successful Lactation:

Following are the signs of successful lactation:

- The baby takes slow, deep suckles followed by a visible or audible swallow about once per second.
- The baby pauses for a few seconds, allowing the ducts to fill up with milk again.
- Upon suckling again, he or she may suckle quickly a few times, stimulating milk flow, and then the slow deep suckles begin.
- The baby's cheeks remain rounded during the feed.
- Towards the end of a feed, suckling usually slows down, with fewer deep suckles and longer pauses between them.

- At the end of session the time when the volume of milk is less, but as it is fat-rich hindmilk, it is important for the feed to continue.
- When the baby is satisfied, he or she usually releases the breast spontaneously. The nipple may look stretched out for a second or two, but it quickly returns to its resting form.

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Poor Latching Fails Successful Lactation

Signs of Ineffective Suckling

Following are the signs of ineffective suckling:

- A baby with poor latching is likely to suckle ineffectively.
- The child may suckle too fast, without swallowing, and the cheeks may be drawn in as he or she suckles showing that milk is not flowing well into the baby's mouth.
- As the baby stops feeding, the nipple may stay look stretched out, and look squashed from side to side, with a pressure line across the tip, showing that the nipple is being damaged by incorrect suction.

Ineffective Suckling Impacts Baby's Nourishment

Poor latching causes the breast may become engorged, a blocked duct or mastitis. Due to this the baby's intake of breast milk will be insufficient, resulting in poor weight gain.

Reasons of Poor Attachment

Following are the possible reasons for poor attachment:

- Has the infant been introduced to feeding bottle? Use of a feeding bottle before breastfeeding is well established can cause poor attachment, because the mechanism of suckling with a bottle is different.
- Is the breast shape conducive to feeding? Functional difficulties such as flat and inverted nipples, or a very small or weak infant, are also causes of poor attachment.
- Supportive breastfeeding mother and caregivers? However, the most important causes are inexperience of the mother and lack of skilled help from the health workers who attend her. Many mothers need skilled help in the early days to ensure that the baby attaches well and can suckle effectively. Health workers need to have the necessary skills to give this help.

Positioning the Mother and Baby for Good Attachment

To be well attached at the breast, a baby and his or her mother need to be appropriately positioned. There are several different positions for them both, but some key points need to be followed in any position.

Position of the Mother

The mother can be sitting or lying down, or standing, if she wishes. However, she needs to be relaxed and comfortable, and without strain, particularly of her back.

If she is sitting, her back needs to be supported, and she should be able to hold the baby at her breast without leaning forward (Refer Figure 6.2).



Fig. 6.2 *Baby Well Positioned at the Breast*

Position of the Baby

The baby can breastfeed in several different positions in relation to the mother: across her chest and abdomen, under her arm, or alongside her body.

Whatever the position of the mother, and the baby's general position in relation to her, there are four key points about the position of the baby's body that are important to observe.

- The baby's body should be straight, not bent or twisted. The baby's head can be slightly extended at the neck, which helps his or her chin to be close in to the breast.
- He or she should be facing the breast. The nipples usually point slightly downwards, so the baby should not be flat against the mother's chest or abdomen, but turned slightly on his or her back able to see the mother's face.
- The baby's body should be close to the mother which enables the baby to be close to the breast, and to take a large mouthful.
- His or her whole body should be supported. The baby may be supported on the bed or a pillow, or the mother's lap or arm. She should not support only the baby's head and neck. She should not grasp the baby's bottom, as this can pull him or her too far out to the side, and make it difficult for the baby to get his or her chin and tongue under the areola.

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Breastfeeding Pattern

Encourage demand feeding, unrestricted feeding, or baby-led feeding: To ensure adequate milk production and flow for 6 months of exclusive breastfeeding, a baby needs to feed as often and for as long as he or she wants, both day and night. Babies feed with different frequencies, and take different amounts of milk at each feed. The 24 hour intake of milk varies between mother-infant pairs from 440–1220 ml, averaging about 800 ml per day throughout the first 6 months. Infants who are feeding on demand according to their appetite obtain what they need for satisfactory growth. They do not empty the breast, but remove only 63–72% of available milk. More milk can always be removed, showing that the infant stops feeding because of satiety, not because the breast is empty. However, breasts seem to vary in their capacity for storing milk. Infants of women with low storage capacity may need to feed more often to remove the milk and ensure adequate daily intake and production.

It is thus important not to restrict the duration or the frequency of feeds provided the baby is well attached to the breast. Nipple damage is caused by poor attachment and not by prolonged feeds. The mother learns to respond to her baby's cues of hunger and readiness to feed, such as restlessness, rooting (searching) with his mouth, or sucking hands, before the baby starts to cry. The baby should be allowed to continue suckling on the breast until he or she spontaneously releases the nipple. After a short rest, the baby can be offered the other side, which he or she may or may not want.

If a baby stays on the breast for a very long time (more than one half hour for every feed) or if he or she wants to feed very often (more often than every 1–1½ hours each time) then the baby's attachment needs to be checked and improved. Prolonged, frequent feeds can be a sign of ineffective suckling and inefficient transfer of milk to the baby. This is usually due to poor attachment, which may also lead to sore nipples. If the attachment is improved, transfer of milk becomes more efficient, and the feeds may become shorter or less frequent. At the same time, the risk of nipple damage is reduced.

Mothers and Families Need to be Supported for their Infants to be Optimally Breastfed

Lactation Friendly Initiatives

- Encourage skin-to-skin contact between mother and baby immediately after birth.
- Begin initiation of breastfeeding within the first hour of life by offering colostrums.
- Breastfeeding on demand by the baby.
- Making room for the mother and infants to remain together 24 hours a day.
- Janam Ghuttis and water not to be given.

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- Provision of supportive health services with infant and young child feeding counselling during all contacts with caregivers and young children, such as during antenatal and postnatal care, well-child and sick child visits, and immunization.
- Community support, including mother support groups and community-based health promotion and education activities.

Check Your Progress

1. What does physiology of lactation involves?
2. Why is breast milk important?
3. Give the common reason for a mother to stop breastfeeding.
4. List the possible reasons for a mother to not produce enough milk.
5. What is the main benefit of breastfeeding?
6. How breastfeeding helps if started at early stage?
7. What are the different nutrients that a mother's breast milk contain?

6.3 GROWTH AND NUTRITIONAL ASSESSMENT OF INFANT'S LACTATION AND THEIR FEEDING METHODS

To determine the growth and nutritional assessment of newborn babies fed by breast milk the health care providers determine whether a baby is getting enough milk based on the following:

Number of feeding sessions the mother offers in the first week of life, mother should be generally nurse 8 to 12 times in 24 hours while at the fourth week post-delivery, nursing usually decreases to 7 to 9 times per day.

Amount of Urine and Stool the Baby Excretes Determines the Appropriate Feeding: On fifth day of life the infant receiving enough milk will urinate six to eight times a day and will pass three or more stools in a day. The colostrum acts like a laxative and help the baby to pass meconium the sticky black first stool. As the day progresses the stools become loose and pale yellow by the 7th day post-delivery indicating that the baby is well fed. Meconium by the fourth day is a warning that child is under fed.

Weight of the baby is a measurement of nourishment. A full term infant will lose an average of 7 percent of their birth weight in the first three to five days of life. This lost weight will typically get back to the original birth weight within one to two weeks. Once a mother's breasts fill with milk by the third to fifth day and with progressive feeding the infant should not keep losing weight. If an infant has lost 10 percent of his or her weight or fails to return to his or her birth weight when

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expected, health care providers start to explore potential problems. Household scales are not accurate enough to detect these small weight differences. If a medical scale is used for infants the weight of the infant is measured with the same clothes and diaper before and after the feeding.

Management of inadequate intake examination by the pediatric health care provider requires examination to check if the baby has a good latch and lactation nurses will convince mothers to try to feed more often or try to stimulate more milk production by using a breast pump or expressing by hand, especially after a feeding. In India, galactagogues or lactagogues like gond ladoo, methi seeds, fennel seeds are supposedly known to increase milk production and are commonly used in household for lactation moms.

Nipple and Breast Pain

The second most common reason mothers stop breastfeeding early is nipple or breast pain:

- Nipple injury which is caused by the baby sucking or a breast pump.
- Engorgement due to the breasts being overly full.
- Plugged milk ducts.
- Infections in the nipple and breast.
- Excessive milk supply.
- Disorders in the skin such as dermatitis or psoriasis that affect the nipple.
- Nipple vasoconstriction, which means the blood vessels in the nipple tighten and do not let enough blood through.

Possible Causes of Breast or Nipple Pain Pertaining

Following are the possible causes of breast or nipple pain pertaining:

- Ankyloglossia which is referred as tongue-tie, which is when the baby's tongue cannot move as freely as it should, making it hard for the baby to suckle effectively.
- Torticollis is the condition when the baby's neck is twisted, making it hard for the baby to nurse from both breasts comfortably.
- These are birth defects in the shape of the baby's mouth that make it hard for the baby to latch on to the mother's breast and effect feeding as well as nourishment.
- When the baby does not move his or her tongue in the correct rhythm to extract milk is uncoordinated sucking.
- The lactation consultant can help upon the examination watching the mother breastfeed and help accordingly.

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6.3.1 Breastfeeding Methods: Rectified and Improvisations

Incase of Nipple Pain During Lactation

Sore nipples due to nipple injury needs to be distinguished from nipple sensitivity, which normally increases during pregnancy and peaks approximately four days after giving birth.

The nipple sensitivity and pain caused by nipple injury based on when it happens and how it changes over time. Normal sensitivity typically subsides 30 seconds after suckling begins. It also diminishes on the fourth day after giving birth and completely resolves when the baby is approximately one week old. Nipple pain caused by trauma, on the other hand, persists or gets worse after suckling begins. Severe pain or pain that continues after the first week after birth is more likely to be due to nipple injury.

The normal nipple sensitivity is discomfort related to normal nipple sensitivity the 'pins and needles' sensation of milk let-down to be uncomfortable that resolves in the first weeks of breastfeeding.

The nipple injury due to incorrect breastfeeding technique particularly poor position or latch-on or harsh breast cleansing, use of potentially irritating products, and biting by an older infant.

To Prevent Nipple Injury:

Position the baby so that the baby can latch on properly.

It is suggested that nipples to be kept dry and allow them to be cleaned and air-dry after feedings. The use of harsh soaps or cleansers on the breasts is to be avoided. The breast pads that have plastic backing is to be avoided. In case of the baby's mouth abnormalities, such as tongue-tie need to be addressed with a surgery to release the tongue will make it easier for the baby to latch on properly (Refer Figure 6.3).

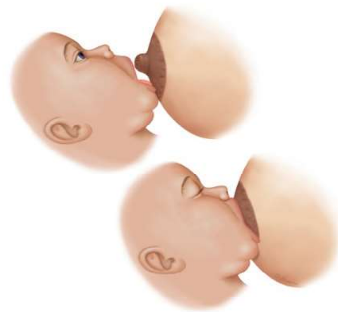


Fig. 6.3 *Latchon*

The nipples that are cracked can be healed with ointment lanolin or coconut oil and use cool or warm compresses.

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Nipple vasoconstriction is when the blood vessels in the nipple tighten and do not let enough blood through. Mothers with this problem can have pain, burning, or numbness in their nipples in response to cold, nursing, or injury. The nipples can also turn white or blue and then pink when the blood returns. To manage nipple vasoconstriction the mothers need to try to keep your whole body warm and dress warmly.

Engorgement is when the breasts get too full of milk can cause pain and tenderness. To prevent and deal with engorgement manually express a small amount of milk before each feeding to soften your areola and make it easier for the baby to latch on by placing your thumb and forefingers well behind your areola which is close to the mother's chest and then compress them together and toward the nipple in a rhythmic fashion. The use of hand to present the nipple in a way that is easier to latch on to and to help get milk out for the baby while the baby is suckling is encouraged.

Plugged ducts can lead to a plugged milk duct include poor feeding technique, wearing tight clothing or an ill-fitting bra, abrupt decrease in feeding, engorgement, and infections.

To prevent and deal with a plugged duct position the baby so that the chin is near the plugged area because this positioning can help drain that area best. The mother can also try pumping or manually expressing after feedings to improve drainage. The quitting of breastfeeding could lead to engorgement and worsen the problem.

Galactoceles is a milk-filled cyst that are usually painless, but they can get quite large and a health care provider can drain a galactocele using a needle or suggest surgery if the problem is severe.

Breast Infections

Lactational mastitis is an inflammation of the breast that is often associated with fever which might be masked by pain medications, muscle and breast pain, and redness that occurs at any time during lactation, but it is most common during the first six weeks after delivery. The doctor may suggest antibiotics and encourage continue breastfeeding so that the breasts empty well.

Seek Help for Breast Feeding

If the mother is unable to breastfeed due to engorgement, pain, or difficulty latching the infant, help from obstetrical or pediatric health care provider, nurse, lactation consultant, or a breastfeeding counselor is necessary.

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Check Your Progress

8. How is it determined that whether a baby is getting enough milk or not?
9. What happens on fifth day of life the infant who is receiving enough milk?
10. Why do women stop breastfeeding at an early stage?
11. How can cracked nipples be healed?
12. What does nipple vasoconstriction mean?
13. Define the term engorgement.
14. What does plugged ducts lead to?

6.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. The physiology of lactation involves the pituitary gland hormones - prolactin and oxytocin that are required to maintain milk secretion.
2. Breast milk provides all the energy and nutrients that the infant needs for the first months of life, and it continues to provide up to half or more of a child's nutritional needs during the second half of the first year, and up to one third during the second year of life.
3. The common reason for a mother to stop breastfeeding is inadequate milk supply.
4. There are a number of reasons why a mother might not produce enough milk, including:
   - Underdeveloped breast development sufficiently during pregnancy hence not having enough milk-producing tissue which is the glandular tissue.
   - Mother's previous breast surgery or radiation treatment.
   - A hormonal imbalance in the mother.
   - Certain medications that interfere with milk production in the mother.
5. The main benefit of breastfeeding is protection against gastrointestinal infections due to early initiation of breastfeeding which is within 1 hour of birth, protects the newborn from acquiring infections and reduces newborn mortality.
6. Breastfeeding and especially early breastfeeding, is one of the most significant ways to improve infant survival rates. The evidence on research shows that Antiretroviral Treatment (ART) given to mothers living with HIV significantly reduces the risk of transmission of HIV through breastfeeding to the infant while also improves her health.

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7. Mother's breast milk contains all the nutrients that an infant needs in the first 6 months of life inclusive of fat, carbohydrates, proteins, vitamins, minerals and water. The breast milk is easily digested by the infant and efficiently utilized by the gut. Scientific studies show that breast milk also contains bioactive factors that augment the infant's immature immune system, providing protection against infection, and other factors that help digestion and absorption of nutrients.
8. To determine the growth and nutritional assessment of newborn babies fed by breast milk the health care providers determine whether a baby is getting enough milk based on the number of feeding sessions the mother offers in the first week of life, mother should be generally nurse 8 to 12 times in 24 hours while at the fourth week post-delivery, nursing usually decreases to 7 to 9 times per day.
9. On fifth day of life the infant receiving enough milk will urinate six to eight times a day and will pass three or more stools in a day. The colostrum acts like a laxative and help the baby to pass meconium the sticky black first stool. As the day progresses the stools become loose and pale yellow by the 7th day post-delivery indicating that the baby is well fed. Meconium by the fourth day is a warning that child is under fed.
10. The second most common reason mothers stop breastfeeding early is nipple or breast pain:
    - Nipple injury which is caused by the baby sucking or a breast pump.
    - Engorgement due to the breasts being overly full.
    - Plugged milk ducts.
    - Infections in the nipple and breast.
    - Excessive milk supply.
11. The nipples that are cracked can be healed with ointment lanolin or coconut oil and use cool or warm compresses.
12. Nipple vasoconstriction is when the blood vessels in the nipple tighten and do not let enough blood through. Mothers with this problem can have pain, burning, or numbness in their nipples in response to cold, nursing, or injury. The nipples can also turn white or blue and then pink when the blood returns. To manage nipple vasoconstriction the mothers need to try to keep your whole body warm and dress warmly.
13. Engorgement is when the breasts get too full of milk can cause pain and tenderness.
14. Plugged ducts can lead to a plugged milk duct include poor feeding technique, wearing tight clothing or an ill-fitting bra, abrupt decrease in feeding, engorgement, and infections.

6.5 SUMMARY

NOTES

- Lactation is natural process of feeding the infant with breast milk.
- The physiology of lactation involves the pituitary gland hormones - prolactin and oxytocin that are required to maintain milk secretion.
- The hormone prolactin maintains synthesis of milk products while oxytocin stimulates the letdown response that allows the infant to extract milk from the gland.
- Breast milk provides all the energy and nutrients that the infant needs for the first months of life, and it continues to provide up to half or more of a child's nutritional needs during the second half of the first year, and up to one third during the second year of life.
- The infants should be breastfed on demand that is as often as the child is hungry and cries for feed.
- It is advisable that from the age of 6 months the infants should be fed on hygienic, safe and adequate complementary foods while continuing to breastfeed for up to 2 years and beyond if possible.
- Breast milk is essential for energy and nutrients during illness and reduces infection among children with malnourishment.
- It is observed that 50 percent of the women make consider breast milk as a feeding option even prior to their conception, while the some may make the decision only during their initial pregnancy.
- It has been observed that during prenatal session pregnant women often abate breastfeeding counseling deferring it until later visits.
- Observational evidence is suggestive of the fact that many gestational women are actually unaware and blindsided by issues encountered during breastfeeding thereby it is suggestive that earlier breastfeeding conversations may actually facilitate enhanced breastfeeding preparation, confidence, and success.
- The common reason for a mother to stop breastfeeding is inadequate milk supply.
- During the first few days after birth the babies are generally sleepy and probably this prevents the baby from getting enough milk feed from lactation.
- Few babies may have weak control of the muscles involved in suckling, which makes it a bit of a task for them to extract milk.
- It is observed that feeding is very difficult naturally among premature and late preterm babies.
- Breastfeeding for 6 months is beneficial for both the infant and mother.

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- The main benefit of breastfeeding is protection against gastrointestinal infections due to early initiation of breastfeeding which is within 1 hour of birth, protects the newborn from acquiring infections and reduces newborn mortality.
- Breast milk is essential for energy and nutrients during illness and reduces infection among children with malnourishment.
- Breastfeeding allows spacing between pregnancies as exclusive breastfeeding of babies under the age of 6 months has a hormonal effect which often induces a lack of menstruation.
- Breastfeeding and especially early and exclusive breastfeeding, is one of the most significant ways to improve infant survival rates.
- The evidence on research shows that Antiretroviral Treatment (ART) given to mothers living with HIV significantly reduces the risk of transmission of HIV through breastfeeding to the infant while also improves her health.
- Mother's breast milk contains all the nutrients that an infant needs in the first 6 months of life inclusive of fat, carbohydrates, proteins, vitamins, minerals and water.
- The breast milk is easily digested by the infant and efficiently utilized by the gut.
- Scientific studies show that breast milk also contains bioactive factors that augment the infant's immature immune system, providing protection against infection, and other factors that help digestion and absorption of nutrients.
- Breast milk provides about one half of the energy content of the milk contains about 3.5 g of fat per 100 ml of milk.
- The fat in the breast milk is secreted in droplets and the amount increases as the breast feeding progresses.
- The hindmilk which is secreted towards the end of a feed is rich in fat and is creamy white, whereas the foremilk at the beginning of a feed contains less fat and may seem bluish-grey in colour.
- Breast milk protein differs in both quantity and quality from animal milks, and it contains a balance of amino acids which makes it much more suitable for a baby.
- The concentration of protein in breast milk (0.9 g per 100 ml) is lower than in animal milks.
- Breast milk contains less of the protein casein, and this casein in breast milk has a different molecular structure.
- Incase of a healthy mother with no deficiencies the breast milk normally contains sufficient vitamins for an infant with the exception is vitamin D.
- The baby's reflexes- rooting, suckling and swallowing are important for appropriate breastfeeding.

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- As the baby suckles, a wave passes along the tongue from front to back, pressing the teat against the hard palate, and pressing milk out of the sinuses into the baby's mouth from where he or she swallows it.
- The baby uses suction mainly to stretch out the breast tissue and to hold it in his or her mouth.
- The oxytocin reflex makes the breast milk flow along the ducts, and this action of the baby's tongue presses the milk from the ducts into the baby's mouth.
- When a baby is well attached his mouth and tongue do not rub or traumatise the skin of the nipple and areola. A good latching ensures that suckling is comfortable without pain.
- To be well attached at the breast, a baby and his or her mother need to be appropriately positioned.
- The baby can breastfeed in several different positions in relation to the mother: across her chest and abdomen, under her arm, or alongside her body.
- To determine the growth and nutritional assessment of newborn babies fed by breast milk the health care providers determine whether a baby is getting enough milk based on the number of feeding sessions the mother offers in the first week of life, mother should be generally nurse 8 to 12 times in 24 hours while at the fourth week post-delivery, nursing usually decreases to 7 to 9 times per day.
- On fifth day of life the infant receiving enough milk will urinate six to eight times a day and will pass three or more stools in a day. The colostrum acts like a laxative and help the baby to pass meconium the sticky black first stool.
- As the day progresses the stools become loose and pale yellow by the 7th day post-delivery indicating that the baby is well fed. Meconium by the fourth day is a warning that child is under fed.
- Sore nipples due to nipple injury needs to be distinguished from nipple sensitivity, which normally increases during pregnancy and peaks approximately four days after giving birth.
- The nipples that are cracked can be healed with ointment lanolin or coconut oil and use cool or warm compresses.
- Nipple vasoconstriction is when the blood vessels in the nipple tighten and do not let enough blood through.
- Engorgement is when the breasts get too full of milk can cause pain and tenderness.
- Plugged ducts can lead to a plugged milk duct include poor feeding technique, wearing tight clothing or an ill-fitting bra, abrupt decrease in feeding, engorgement, and infections.

- Galactoceles is a milk-filled cyst that are usually painless, but they can get quite large and a health care provider can drain a galactocele using a needle or suggest surgery if the problem is severe.

NOTES

6.6 KEY WORDS

- **Lactation:** Lactation is natural process of feeding the infant with breast milk.
- **Nipple vasoconstriction**: Nipple vasoconstriction is when the blood vessels in the nipple tighten and do not let enough blood through.
- **Engorgement**: Engorgement is when the breasts get too full of milk can cause pain and tenderness.
- **Galactoceles**: Galactoceles is a milk-filled cyst that are usually painless, but they can get quite large and a health care provider can drain a galactocele using a needle or suggest surgery if the problem is severe.

6.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What is lactation and why is it important?
2. What are reasons for poor extraction of milk?
3. What are the problems faced during lactation?
4. How does a HIV positive mother feed an infant?
5. How does a baby attaches and suckles at the breast?
6. What are the signs of successful lactation?
7. How should a mother and child be positioning during breastfeeding?
8. What is the amount of urine and stool the baby excretes in early days? What does it determines about feeding?
9. How can nipple injury be prevented?
10. Define the following terms:
    i. Nipple vasoconstriction
    ii. Engorgement
    iii. Plugged ducts

Long-Answer Questions

1. Describe in detail about infant lactation.
2. What is the composition of breast milk? Discuss.

3. Discuss the characteristics, causes and complications of infant lactation.
4. Explain about ineffective suckling, its sign, impact and reason.
5. Discuss the pattern of breastfeeding.
6. Elaborate a note on various feeding methods.
7. Describe the growth and nutritional assessment of infant's lactation.

NOTES

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UNIT 7 IDENTIFICATION OF NEWBORN SICKNESS

NOTES

Structure

7.0 Introduction
7.1 Objectives
7.2 Identification of Newborn Sickness
7.2.1 Detection of Jaundice in Newborn
7.2.2 Cyanosis or Respiratory Distress in Newborn
7.2.3 Detection of Respiratory Distress Syndrome in Newborn
7.3 Answers to Check Your Progress Questions
7.4 Summary
7.5 Key Words
7.6 Self Assessment Questions and Exercises
7.7 Further Readings

7.0 INTRODUCTION

Babies are most vulnerable just after birth. They may be born with certain congenital conditions or may contract infections easily. A new parent should be aware of the common health problems that babies encounter and how to tackle them so that they can take care of the baby in the best way possible. Newborn babies do not get contracted by any sickness if babies are breastfed and people around the baby maintain the cleanliness hygiene regularly. But in India 3 out of 100 babies fall sick.

All babies are born with some immunity to illness. Even so, it takes time for their newly developing immune systems to fully mature. This makes babies susceptible to viral infections, which cause colds. There are over 200 types of viruses that can cause colds. Luckily, most of the colds a baby gets helps increase their immunity. Even so, their very first cold can be scary for parents. A baby can catch a cold at any age or time of year. In fact, they may get as many as 8 to 10 a year in their first 2 years. Common colds in newborns are not dangerous, but they can quickly escalate into conditions that are, such as pneumonia or croup. Any illness in a baby under 2 or 3 months old is a reason to call their pediatrician, especially if they're running a fever.

One of the common ailments can be caused by early delivery of the baby which is also termed as premature also the body weight of the new-born baby is quite low, meaning low birth rate. In India around 40% new-born babies weigh less than 2.5 specially babies weighing 2 or 1.5 have ailment regarding premature or low birth weight. The temperature maintenance mechanism of these babies has

some problems. These babies have problems while breastfeeding, they also tend to have jaundice and these babies need to be taken into Neonatal Intensive Care Unit (NICU) for extra care. Almost 15% of babies in India are premature babies and they require NICU care. Babies have very low immunity power and they are more prone to infections. Our hands and clothes cause infections. Therefore, it's important that people surrounding the baby should maintain cleanliness, wash and scrub their hands before encountering the baby. There are different types of infection like pneumonia, blood infections, brain infection, etc. And if these infections are contracted by the babies then they must be admitted to NICU. The most common illness among the babies around the world is jaundice. Jaundice in babies is caused due to liver immature which is called physiological jaundice. Hardly 5-6% cases have serious jaundice where the babies undergo phototherapy. Or it gets cured in 3-4 days. But if the mother's blood group has -ve or o+ blood group, then even if the baby has +ve blood group or A and B blood group at that time babies Red Blood Cells (RBC) break down faster, and because of this breakdown the jaundice is more severe. Difficulty in breathing surfactant level in lungs decreases which leads to breathing problems and because of that these babies must be kept on a ventilator. In medical term this condition is called as RDS, i.e., Respiratory Distress Syndrome. Around 3-5% babies are born with birth defects which is called congenital disorder. Around about 40-50% of these diseases are detected in the earlier stage of pregnancy at the time of sonography. All diseases are not detected on sonography. 3-5% babies suffer from congenital anomaly wherein majority of babies have heart and brain ailments.

In this unit, you will study about the identification of newborn sickness, detection of abnormal signs like cyanosis, jaundice and respiratory distress.

7.1 OBJECTIVES

After going through this unit, you will be able to:

- Analyse the identification of newborn sickness
- Understand the detection of abnormal signs
- Discuss about cyanosis, jaundice and respiratory distress

7.2 IDENTIFICATION OF NEWBORN SICKNESS

Global trends show that the three major causes of mortality in newborn are infections due to sepsis/pneumonia, tetanus and diarrhea, pre-term birth or birth asphyxia. The main cause of newborn sickness and mortality is due to lack of necessary continuum between maternal and child health services. Reports indicate that more than half the deaths in neonates occur after a home birth and without any access to

health care. Emphasis is given by maternity health care providers to communicate effectively on treating maternal infections during pregnancy, ensuring a sterilized birth, hygiene care of the umbilical cord and immediate, exclusive breast-feeding.

For infections, treatment with antibiotics is necessary and needs to be available locally in the region, remote areas and rural communities. The low birth weight babies need to maintain body temperature through skin-to-skin contact with the mother. These simple yet essential interventions help save the lives of mothers and prevent newborn sickness and mortality to large extent.

The national health administrations focus is to create strategies to empower families and communities to close the gap of postnatal care in order to improvise healthy home practices and empowering families to recognize problems and access care will quickly save many lives. In high mortality settings with low access to care, some interventions may need to be provided closer to home.

The gap for care of mothers and babies in the first few days of life is important even where women do deliver in medical facilities. New approaches are required to reach a large majority of these families. Most of the time child birth may be healthy but the infant may develop a condition requiring medical attention.

The new born immune system is not completely developed and inefficient to fight against the bacteria, viruses, and parasites that cause any infections making infants susceptible to any disease. The role of pediatric health care team is to explain parents to watch out for the following signs in their infant and immediately report to the doctor:

- Poor feeding
- Breathing difficulty
- Listlessness
- Decreased or elevated temperature
- Unusual skin rash or change in skin color
- Persistent crying
- Unusual irritability
- Sleeping more than usual

7.2.1 Detection of Jaundice in Newborn

Jaundice in infants is observed as a yellow discoloration of the skin and eyes.

Jaundice is first observed on the face moving to the infant’s chest, belly, arms, and legs as bilirubin levels increase in blood. In the infant the whites of the eyes will also look yellow. Babies with a darker skin tone jaundice can be harder to visualize.

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Parent or caregiver of the newborn must consult a pediatric doctor as soon as they notice:

- Skin colour that indicates a yellow or that starts from the head and spread to the toes.
- The baby does not wake up at all even for feeding or will not sleep at all.
- The newborn is not breastfeeding or sucking from a bottle well.
- The baby is very fussy and will not calm down.
- The mother notices that the infant does not have enough wet or dirty diapers wherein the healthy baby has at least 4-6 thoroughly wet diapers in 24 hours and 3 to 4 stools per day by the fourth day.

The jaundice in newborn infants is due to presence of excess of bilirubin because of rampant breakdown of red blood cells in infants. Infant jaundice is a common condition particularly in babies born before 38 weeks of gestation (preterm babies) and also observed in some breast-fed babies. Infant jaundice will usually be observed because a baby's liver is not viably mature enough to get rid of bilirubin in the bloodstream. In some babies, an underlying disease may also be a responsible cause of infant jaundice. Most infants born between 35 weeks of gestation and full term may not need any treatment for jaundice. In certain situations, the presence of unusually elevated blood level of bilirubin can place a newborn at risk of brain damage, particularly in the presence of certain risk factors for severe jaundice.

In the second or fourth day after birth infant, the skin may show yellowing as well as the whites of the eyes. Parents are asked to check for jaundice in the child by gently pressing on the infant's forehead or nose and the skin will reveal pale yellow tinge upon pressed that indicates mild jaundice. On the other hand if the infant does not have jaundice, the skin color will simply look slightly lighter than its normal color which is pinkish, for a moment. Pediatricians suggest parents that it is advised to examine the baby in good lighting conditions, preferably in natural daylight. Hyper bilirubinemia or excess bilirubinemia is the main cause of jaundice. Bilirubin causes the yellow color of jaundice that provides the pigment released from the breakdown of used RBC, i.e., Red Blood Cells.

- Newborns produce more bilirubin as there is greater production and faster breakdown of red blood cells in the first few days of life.
- The liver will filter bilirubin from the bloodstream and releases it into the intestinal tract but a newborn's immature liver is unable to remove bilirubin as fast as the rapid breakdown, causing an excess of bilirubin.
- Jaundice due to these normal newborn conditions is called physiologic jaundice, and it typically appears on the second or third day of life.
- An underlying disorder may cause infant jaundice. In these cases, jaundice often appears much earlier or much later than does the more common form of infant jaundice.

NOTES

- Diseases or conditions that can cause jaundice include internal bleeding (hemorrhage), infection in your baby's blood (sepsis), viral or bacterial infections, incompatibility between the mother's blood and the baby's blood, liver malfunction, biliary atresia, a condition in which the baby's bile ducts are blocked or scarred, enzyme deficiency, rapid break down of RBC's.

In a pediatric health care set up the cause of jaundice is assessed by doctors and generally, pediatric care of management of jaundice in newborn is undertaken:

Nutrition: Weight loss in the infant needs to be prevented by doctor's recommendation of frequent feeding or supplementation to ensure that the newborn receives adequate nourishment preferably through breast feeding which is encouraged 8-12 feedings a day for the first several days of life.

Incase due to peculiar reasons the lactation is unsuccessful and the infant is formula-fed; encouraging 30 to 60 milliliters of formula every two to three hours for the first week is necessary.

Phototherapy: Phototherapy is a type of medical treatment that involves exposure to fluorescent light bulbs or other sources of light like halogen lights, sunlight, and Light Emitting Diodes (LEDs) to treat certain medical conditions. The management of neonatal jaundice includes that the infant is introduced to direct sunlight or in a clinic may be placed under a special lamp that emits light in the blue-green spectrum. The exposure to light changes the shape and structure of bilirubin molecules in such a way that they can be excreted in both the urine as well as stool.

Intravenous Immunoglobulin (IVIg): Intravenous Immuneglobulin (IVIg) is a product made up of antibodies that can be given intravenously (through a vein). **In case the** jaundice may be related to incompatibility blood type differences between mother and baby contributing to the rapid breakdown of the baby's red blood cells the need for intravenous transfusion of an immunoglobulin a blood protein is necessary that can reduce levels of antibodies which may decrease jaundice and lessen the need for an exchange transfusion, although results are not conclusive.

Blood transfusion is the process of transferring blood products into one's circulation intravenously. **It is done** when severe jaundice in the newborn does not respond to any other treatments, a baby may need an exchange transfusion of blood. This involves repeatedly withdrawing small amounts of blood and replacing it with donor blood, thereby diluting the bilirubin and maternal antibodies a procedure that is performed in a Newborn Intensive Care Unit (NICU).

7.2.2 Cyanosis or Respiratory Distress in Newborn

Cyanosis refers to a bluish cast to the skin and mucous membranes. Peripheral cyanosis is when there is a bluish discoloration to your hands or feet.

It's usually caused by low oxygen levels in the red blood cells or problems getting oxygenated blood to your body. Immediately on birth, on pediatrician's physical examination of the infant incase indicates an appearance of blue skin, cyanosis is considered in the newborn. At the immediate birth of a newborn the on duty pediatrician will check the infant incase of increased respiratory effort with increased rate, nasal flaring or a murmur. Observations indicating any muffled heart sounds can indicate pericardial effusions or pneumopericardium. Infants with respiratory distress or congenital heart disease may require special care during feeding.

Detection of Abnormal Signs of Cyanosis or Respiratory Distress in Newborn

Tachypnea is the most common presentation in newborns with respiratory distress. A normal respiratory rate is 40 to 60 respirations per minute.

Other signs of cyanosis or respiratory distress in newborn include:

- Nasal Flaring
- Grunting
- Intercostal or Subcostal Retractions
- Cyanosis

The newborn may also have:

- Lethargy
- Poor Feeding
- Hypothermia
- Hypoglycemia

7.2.3 Detection of Respiratory Distress Syndrome in Newborn

The Respiratory Distress Syndrome is generally suspected in premature infants possibly because of surfactant deficiency and underdeveloped lung anatomy. Pediatricians are of the opinion that Meconium aspiration syndrome is possibly due to in utero fetal distress by hypoxia.

Also, possible congenital malformations may lead to respiratory distress includes:

- Pulmonary hypoplasia
- Congenital emphysema
- Esophageal atresia
- Diaphragmatic hernia
- Neurologic disorders; hydrocephalus and intracranial hemorrhage
- Central respiratory depression is seen in newborns after maternal exposure to medications, including labor analgesia and illicit drugs

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- Metabolic and hematologic derangements, such as hypoglycemia, hypocalcemia, polycythemia, and anemia may cause respiratory symptoms
- Inborn errors of metabolism are also considered

In a healthcare set up clinically, the Initial evaluation for persistent or severe respiratory distress comprises of undertaking complete blood count with differential, chest radiography, and pulse oximetry. Treatment for neonatal respiratory distress can be both generalized and disease-specific under the supervision of neonatal pediatricians.

Newborn babies with special health considerations like jaundice, respiratory distress or cyanosis may require support in feeding with breastfeeding or NICU care.

Check Your Progress

1. What are the three major causes of mortality in newborn?
2. Give the main cause of newborn sickness and mortality.
3. What is the role of pediatric health care team to in explaining the parents to watch for the symptoms in infants?
4. Define the term jaundice.
5. What are the early body parts where the jaundice can be first seen in infants?
6. What is phototherapy?
7. Expand the term IVIg. Give its use.
8. How is blood transfusion helpful?
9. Give the cause of cyanosis.
10. List the signs of cyanosis that are observed in a newborn.

7.3 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. The three major causes of mortality in newborn are infections due to sepsis/ pneumonia, tetanus and diarrhea, pre-term birth or birth asphyxia.
2. The main cause of newborn sickness and mortality is due to lack of necessary continuum between maternal and child health services.
3. The role of pediatric health care team is to explain parents to watch out for the following signs in their infant and immediately report to the doctor:
   - Poor feeding
   - Breathing difficulty
   - Listlessness

- Decreased or elevated temperature
- Unusual skin rash or change in skin color
- Persistent crying

4. Jaundice in infants is observed as a yellow discoloration of the skin and eyes.
5. Jaundice is first observed on the face moving to the infant's chest, belly, arms, and legs as bilirubin levels increase in blood. In the infant the whites of the eyes will also look yellow.
6. Phototherapy is the management of neonatal jaundice includes that the infant is introduced to direct sunlight or in a clinic may be placed under a special lamp that emits light in the blue-green spectrum.
7. Intravenous Immuneglobulin (IVIg) is a product made up of antibodies that can be given intravenously (through a vein). In case the jaundice may be related to incompatibility blood type differences between mother and baby contributing to the rapid breakdown of the baby's red blood cells the need for intravenous transfusion of an immunoglobulin a blood protein is necessary that can reduce levels of antibodies which may decrease jaundice and lessen the need for an exchange transfusion, although results are not conclusive.
8. Blood transfusion is the process of transferring blood products into one's circulation intravenously. It is done when severe jaundice in the newborn does not respond to any other treatments, a baby may need an exchange transfusion of blood. This involves repeatedly withdrawing small amounts of blood and replacing it with donor blood, thereby diluting the bilirubin and maternal antibodies a procedure that is performed in a Newborn Intensive Care Unit (NICU).
9. Cyanosis refers to a bluish cast to the skin and mucous membranes. Peripheral cyanosis is when there is a bluish discoloration to your hands or feet. It's usually caused by low oxygen levels in the red blood cells or problems getting oxygenated blood to your body.
10. The signs of cyanosis or respiratory distress in newborn include:
    - Nasal Flaring
    - Grunting
    - Intercostal or Subcostal Retractions
    - Cyanosis

7.4 SUMMARY

- Global trends show that the three major causes of mortality in newborn are infections due to sepsis/pneumonia, tetanus and diarrhea, pre-term birth or birth asphyxia.

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- The main cause of newborn sickness and mortality is due to lack of necessary continuum between maternal and child health services.
- The low birth weight babies need to maintain body temperature through skin-to-skin contact with the mother.
- Most of the time child birth may be healthy but the infant may develop a condition requiring medical attention.
- The new born immune system is not completely developed and inefficient to fight against the bacteria, viruses, and parasites that cause any infections making infants susceptible to any disease.
- Jaundice in infants is observed as a yellow discoloration of the skin and eyes.
- Jaundice is first observed on the face moving to the infant's chest, belly, arms, and legs as bilirubin levels increase in blood. In the infant the whites of the eyes will also look yellow.
- Babies with a darker skin tone jaundice can be harder to visualize.
- The jaundice in newborn infants is due to presence of excess of bilirubin because of rampant breakdown of red blood cells in infants.
- Infant jaundice is a common condition particularly in babies born before 38 weeks of gestation (preterm babies) and also observed in some breast-fed babies.
- Infant jaundice is usually observed because a baby's liver is not viably mature enough to get rid of bilirubin in the bloodstream.
- In some babies, an underlying disease may also be a responsible cause of infant jaundice.
- Most infants born between 35 weeks of gestation and full term may not need any treatment for jaundice.
- In certain situations, the presence of unusually elevated blood level of bilirubin can place a newborn at risk of brain damage, particularly in the presence of certain risk factors for severe jaundice.
- In the second or fourth day after birth infant, the skin may show yellowing as well as the whites of the eyes.
- Hyper bilirubinemia or excess bilirubinemia is the main cause of jaundice.
- Bilirubin causes the yellow color of jaundice that provides the pigment released from the breakdown of used red blood cells.
- Newborns produce more bilirubin as there is greater production and faster breakdown of red blood cells in the first few days of life.
- Weight loss in the infant needs to be prevented by doctor's recommendation of frequent feeding or supplementation to ensure that the newborn receives

NOTES

adequate nourishment preferably through breast feeding which is encouraged 8-12 feedings a day for the first several days of life.

- The management of neonatal jaundice includes that the infant is introduced to direct sunlight or in a clinic may be placed under a special lamp that emits light in the blue-green spectrum.
- Blood transfusion is done when severe jaundice in the newborn does not respond to any other treatments, a baby may need an exchange transfusion of blood.
- Tachypnea is the most common presentation in newborns with respiratory distress.
- The Respiratory Distress Syndrome is generally suspected in premature infants possibly because of surfactant deficiency and underdeveloped lung anatomy.
- Central respiratory depression is seen in newborns after maternal exposure to medications, including labor analgesia and illicit drugs.
- Metabolic and hematologic derangements, such as hypoglycemia, hypocalcemia, polycythemia, and anemia may cause respiratory symptoms.

7.5 KEY WORDS

- **Jaundice**: Jaundice in infants is observed as a yellow discoloration of the skin and eyes.
- **Phototherapy**: Phototherapy is a type of medical treatment that involves exposure to fluorescent light bulbs or other sources of light like halogen lights, sunlight, and Light Emitting Diodes (LEDs) to treat certain medical conditions.
- **Intravenous Immunoglobulin (IVIg):** Intravenous Immunoglobulin (IVIg) is a product made up of antibodies that can be given intravenously (through a vein).
- **Blood transfusion**: Blood transfusion is the process of transferring blood products into one's circulation intravenously.
- **Cyanosis**: Cyanosis refers to a bluish cast to the skin and mucous membranes.

7.6 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What is jaundice and how it is observed in newborns?

NOTES

2. List the different signs that are to be observed in a newborn that may indicated towards jaundice.
3. What type of nutrition is given to a newborn suffering from jaundice?
4. Distinguish between phototherapy and IVIg.
5. What happens in cyanosis?

Long-Answer Questions

1. Explain how the identification of newborn sickness is done?
2. What is blood transfusion and how is it done?
3. Describe the detection of abnormal signs of illness in a newborn.
4. Discuss about cyanosis and jaundice, their symptoms, cure and nutrition in a newborn.
5. Explain about respiratory distress, its causes and identification in a newborn.

7.7 FURTHER READINGS

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UNIT 8 PROBLEMS OF NEWBORN SICK

NOTES

Structure

8.0 Introduction
8.1 Objectives
8.2 Newborn Illness: Bleeding, Seizures, Refusal and Feed, Abdominal Distention, Failure to Pass Meconium and Urine
8.2.1 Bleeding
8.2.2 Seizure
8.2.3 Refusal to Feed
8.2.4 Failure to Pass Meconium and/or Urine
8.2.5 Abdominal Distention
8.3 Answers to Check Your Progress Questions
8.4 Summary
8.5 Key Words
8.6 Self Assessment Questions and Exercises
8.7 Further Readings

8.0 INTRODUCTION

Children in the neonatal period are very challenging to clinicians. The transition from intrauterine to extrauterine life results in a vulnerable state for the neonate. Genetic disorders, congenital anomalies, and metabolic issues may all present in the first month of life. Discerning normal from abnormal can be very difficult, and recognizing subtle abnormalities may facilitate an early diagnosis, thus improving the infant's chances for a normal life. Important areas are addressed by organ system with both benign and life-threatening diseases reviewed.

The vast majority of newborns enter the world healthy. But sometimes, infants develop conditions that require medical tests and treatment. Newborns are particularly susceptible to certain diseases, much more so than older children and adults. Their new immune systems aren't adequately developed to fight the bacteria, viruses, and parasites that cause these infections. As a result, when newborns get sick, they may need to spend time in the hospital or even the Neonatal Intensive Care Unit (NICU) to recover.

Infants are vulnerable just after birth and as they make a transition from the safety of the womb to this world. It is the time when they learn to breathe, feed, and more. It is also the time when their lungs, heart, brain, kidneys, liver, etc., learn to coordinate. If they feel any discomfort, the only way they can communicate is by crying. As a parent, you should try and understand what might be troubling your baby and consult your baby's doctor immediately.

Abdominal distension can occur in newborns and healthy infants. One of the prominent causes of abdominal distension in infants is swallowing of excess air. Parents need to observe the belly of the infant. Newborns have protruding and soft bellies. If your baby's belly feels hard and swollen when you touch it, it could be because of gas or constipation. As the baby's body begins to adjust to feeding, the problem should get resolved. However, if a bluish tinge persists and much distension of the abdomen is present, it could mean a serious underlying problem with the internal organs. Hemorrhagic disease of the newborn is a rare bleeding problem that can occur after birth. Hemorrhaging is excessive bleeding. It is a potentially life-threatening condition. The condition is caused by vitamin K deficiency. As a result, it is often called Vitamin K Deficiency Bleeding, or VKDB. Vitamin K plays a key role in blood clotting. Because vitamin K is not efficiently passed on from mother to baby in utero, most babies are born with low stores of this vitamin in their system. Seizures in newborns are different from seizures that occur in older children and adults. The seizures often are fragmentary because the infant's brain is still developing and is unable to make the coordinated responses seen in a typical generalized tonic-clonic seizure.

In this unit, you will study about bleeding, seizures, refusal and feed, abdominal distention, failure to pass meconium and urine of sick newborn.

8.1 OBJECTIVES

After going through this unit, you will be able to:

- Explain bleeding and seizures of sick newborn
- Understand why a sick newborn refuse to eat
- Discuss about abdominal distention of a newborn
- Analyse the reason why a sick newborn in unable to pass meconium and urine

8.2 NEWBORN ILLNESS: BLEEDING, SEIZURES, REFUSAL AND FEED, ABDOMINAL DISTENTION, FAILURE TO PASS MECONIUM AND URINE

In a newborn many problems can be seen, which can be fatal if not observed at the right time. Some of the problems that newborn faces are describe below as follows:

8.2.1 Bleeding

Newborn health may be at threat because of bleeding due to serious cardiovascular or neurological adversities. It is noted in a pediatric medical care the immediate

administration of vitamin K reduces the incidence of hemorrhagic disease of the newborn but abnormal bleeding can occur in babies due to several possibilities. Bleeding in the newborn may be due to cardiovascular effects associated with a loss of blood or the damaging effects of bleeding on neonatal tissues probably in the brain.

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Possible Reasons of Bleeding Before or During Birth:

Transfusion

- Fetal to Maternal
- Twin to Twin
- Placenta Previa, Abruption

Placenta

- Vasa Previa
- Cord Accident
- Intracranial Hemorrhage

Baby

- Cephalohematoma, Subgaleal Hemorrhage
- Abdominal Organs

HELLP: Hypertension, Elevated Liver Enzymes, Low Platelets

History

- Family Bleeding Disorder
- Maternal Illness

Maternal Drugs

- Well or Sick Baby

Physical Examination

- Hepatosplenomegaly
- Bleeding Sites
- Physical Abnormalities

Suspected bleeding in the newborn is of the concern; the pediatrician approach the clinical problem in a systematic manner, as follows:

- Bleeding in newborn require preliminary laboratory evaluation.
- The investigations assist with immediate management and determine the future health implications for the baby.
- The clinical management include potential prevention, measures to ensure cardio respiratory stability, treatment of underlying problems and replacement of coagulation factors.

- Situations that are complicated require investigation and management with consultation of a hematologist who may also assist in follow-up if ongoing problems are anticipated.

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8.2.2 Seizure

Seizure is a sudden, electrical impulse in the brain activity that will cause an involuntary movement like chewing or bicycling in newborn. Seizures have an underlying cause and if left untreated can cause permanent damage to the brain. Infants who have neonatal seizures may develop epilepsy, cerebral palsy, mental retardation and other neurological disorders later in life.

Seizures in neonates can involve these visible symptoms as follows:

- Random roving eye movements where the eyelid blinking or fluttering is rapid, with eyes rolling up or eye opening to staring.
- Obvious sucking, smacking, chewing and protruding of the tongue.
- Untypical bicycling or pedaling movements of the legs.
- Observational thrashing or struggling movements.
- Visible long pauses in breathing (apnea).
- Rhythmic jerking movements that may involve the muscles of the face, tongue, arms, legs or other regions of the body.
- Prominent stiffening or tightening of the muscles.
- Turning the head or eyes to one side, or bending or stretching one or more arms or legs.
- Jerky and quick motions, involving one arm or leg or the whole body.

Diagnosis and treatment of neonatal seizures involves experienced health care team to identify and treat the underlying cause of the seizures. Anticonvulsant medications may be prescribed by the pediatric team while monitoring the infant. Incase, the infant is suffering from a hypoxic ischemic encephalopathy which is a possibility of not receiving enough oxygen to the brain then the infant may receive hypothermia treatment to reduce brain damage which is obviously caused by the lack of oxygen. This hypothermic treatment will ease the cooling of the infant's brain and body by a few degrees immediately after birth for several hours or days. The baby is continuously monitored during treatment, and then slowly re-warmed to normal body temperature.

8.2.3 Refusal to Feed

We know that breastfeeding may seem natural to some mother's but few babies struggle to latch on. Certain infants cannot comply to breastfeed and cry a lot as they find it difficult to latch on and are unable to nurse effectively at breast feeding.

NOTES

Common observations for newborn infants to refuse to breastfeeding are as follows:

- Delivery that is a difficult labour.
- Medication used during labour probably anesthesia, epidural or pethidine that makes the baby sleepy.
- Possible discomfort due to a birth injury or bruising.
- Obvious swallowing of mucus at birth and suctioning can make the infant feel congested, nauseous or uncomfortable.
- Unexpected unpleasant experience of nursing as in being nudged forcefully onto the breast.
- Series of diagnostic pricking for blood tests and other medical procedures while nursing.

It is also observed in premature infants to develop feeding issues. Feeding intolerance is possible among babies born preterm and showing signs of abdominal distension, vomiting, bilious gastric residuals and occult or gross bloody stools.

Necrotizing Enterocolitis (NEC) is an unfavorable gastrointestinal complication in prematurely born infants.

Enteral Nutrition is replaced with Parenteral Nutrition (PN) and central lines in these clinical difficult cases.

- **Preterm Neonates:** Due to expected lapse in coordination between sucking, swallowing and breathing, the infant are usually fed via an intragastric tube, through intermittent boluses or continuously. Poor sucking and sucking-swallowing in coordination are the major causes of feeding disturbances and breastfeeding failure among late preterm infants (Gestational age 34-36$^{6/7}$ weeks), with an increased risk of hypoglycemia, excessive weight loss, hyperbilirubinemia, dehydration. Due to feeding delays, up to 27% of all late preterm infants need to be initially supplemented with intravenous fluids; moreover, tube feeding is frequently required for feeding administration in the first days of life.
- **Healthy Term Newborns:** There may be unexpected feeding issues, such as poor sucking or vomiting that needs to be evaluated for pathological causes. Physical examination could aid to identify anatomical malformations like cleft palate may be of concern. Clinicians will check feeding refusal and excessive sleepiness can be due to hyperbilirubinemia, hypoglycemia or electrolyte disturbances but could also subtend an underlying metabolic disease, such as hypothyroidism.

Pediatricians evaluate all newborns for seizures, focal neurological signs, hypo-or hypertonia, bulging fontanel, central apnea could address for central nervous system diseases-subarachnoid haemorrhage, ischaemic stroke, metabolic

encephalopathy, respiratory distress, apnea and bradycardia, temperature instability and increased capillary refill time. Neonatologists investigate though probing on diagnostic blood tests, such as Complete Blood Count (CBC), C-reactive protein, glucose, bilirubin, electrolytes, blood gas analysis and cerebral ultrasound scan are useful tools to aid pediatric team in the differential diagnosis.

Infants, who may have been diagnosed with a condition that makes him hypotonic, or floppy, will show little interest in breastfeeding and need reinforcement from mother to feed.

8.2.4 Failure to Pass Meconium and/or Urine

A newborn baby's on time passage of the first stool is a sign of the well-being but a failure of a full-term newborn to pass meconium in the first 24 hours may signal intestinal obstruction. Lower intestinal obstruction requires a radiologic study to make the diagnosis.

Generally, the first stool is excreted within 24 hours of birth in most healthy full-term infants but a delay is expected of 48 hours or more in pre-term babies (Refer Table 8.1).

Table 8.1 *Clinical Reasons for Delay in Meconium Excretion or Abdominal Obstructions*

Diagnosis	**Manifestation**	**Treatment**
Hirschsprung's (HIRSH-sproongz) Disease	Tight anus, empty rectum, transition zone	Surgery
Meconium Plug Syndrome	Meconium plugs	Rectal stimulation, enema
Meconium Ileus	Abdominal distention at birth, cystic fibrosis	Enema with intravenous fluids, surgery
Anorectal Malformation	Absent anus, tight anus or fistula	Dilatation, surgery
Small Left Colon Syndrome	Transition zone* at splenic flexure	Enema, rarely, colostomy

It is uncommon but possible that the use of illicit drugs by mother for instance magnesium sulfate and ganglionic blocking agents, can affect the infant and interfere with the passage of meconium.

Possible medical neonatal conditions that can be associated with a clinical expected failure to pass meconium include hypothyroidism, hypercalcemia, hypokalemia, sepsis and congestive heart failure.

Failure to Pass Urine

It is not peculiar to see neonatal anuria in newborns. Incase of the failure to pass urine for 24 hours after birth is anuria in babies. A clinical possibility is due to neonatal acute renal failure medical reason being prerenal, renal and post-renal etiologies.

There can be clinical defects in the urinary tract that can cause urine blockage:

- Vesicoureteral Reflux (VUR)
- Ureteropelvic Junction (UPJ) obstruction

NOTES

- Bladder Outlet Obstruction (BOO), such as Posterior Urethral Valves (PUV) ureterocele
- Prune Belly Syndrome (PBS)
- Esophageal Atresia (EA)
- Congenital heart defects
- Urine blockage can also be caused by spina bifida and other birth defects that affect the spinal cord

Neonatal routine newborn exam in the hospital mandates the health care provider to feel an enlarged kidney or find a closed urethra, which may indicate urine blockage. Sometimes urine blockage is not apparent until a child develops symptoms of a Urinary Tract Infection (UTI).

When a defect in the urinary tract blocks the flow of urine, the urine backs up and causes the ureters to swell, called hydroureter, and hydronephrosis.

Many times, the defects of the urinary tract may be actually discovered before or after the baby is born during the prenatal tests include ultrasound, amniocentesis, and Chorionic Villus Sampling (CVS). These different imaging techniques inclusive of ultrasound, Voiding Cystourethrogram (VCUG), and radionuclide scan, can help determine in infants and children to determine the cause of urine blockage.

In the newborn, the treatment for urine blockage will depend on the individual case cause and the severity of the blockage. Hydronephrosis discovered before the baby is born rarely requires immediate action, especially if it is only on one side of the body but treatments for more serious conditions include surgery or antibiotics intermittent catheterization cannot be ruled out in clinical emergencies.

8.2.5 Abdominal Distention

Abdominal distention is seen in newborns is observed that can be life-threatening in certain cases. There is very less information available regarding early identification of the etiology of abdominal distention in newborn babies which is imperative to limiting the likelihood of serious consequences. This retrospective study was conducted to analyze the clinical characteristics of early newborns with abdominal distention, aiming at identifying the underlying etiologic factors.

The reasons for abdominal distention are as follows:

- Congenital malformations may be the major cause of abdominal distension in early newborns.
- Sepsis and congenital megacolon are the single disease and are most frequently associated with abdominal distention in preterm and full-term newborns respectively.
- Vomiting is a main accompanying symptom in early newborns with abdominal distention.

NOTES

- X-ray manifestations seem to be more severe in preterm newborns than in full term newborns.
- A satisfactory outcome can be achieved after treatment in both preterm and full-term newborns with this disorder.

In newborns a distended bloated belly after feeding milk can be because the baby has swallowed excessive air during the feeding causing gas. The infant will be irritable and cry more than usual because of the discomfort in the belly and will pass more gas than usual, more burps, belch or pass gas excessively.

Although a bloated tummy is harmless in most cases and usually goes away without treatment a few remedies at home are suggested to new moms:

- Feeding the infant in a slightly reclining position to reduce the amount of air the baby swallows.
- Avoid overfeeding the baby by stopping the feed once the infant refuses or turns away from the bottle or breast.
- Burp during and after feeding to avoid the build-up of air in the baby's tummy.

As the distension can sometimes be a sign of an underlying medical condition meeting a doctor is important if child is very irritable and refuses feeds.

Research has always been promising to indicate that maternal health or diet may not be responsible for any of the above conditions in a newborn but having mentioned that, appropriate investigations and clinical management in neonatal illness can help prevent long term progressive disease concerns in the child.

Check Your Progress

1. Why does bleeding occur in newborns?
2. Give the possible reasons of bleeding before or during birth due to transfusion.
3. How does pediatrician approach towards the suspected bleeding in the newborns?
4. What are seizures?
5. Give the symptoms of seizures.
6. List the most common observations for newborn infants to refuse to breastfeeding.
7. What is NEC?
8. In a newborn what does the first stool indicate about?
9. What are the possible defects in the urinary tract that can cause urine blockage?
10. What is abdominal distention?
11. Give the reasons for abdominal distention.

8.3 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

NOTES

1. Newborn health may be at threat because of bleeding due to serious cardiovascular or neurological adversities.
2. Possible reasons of bleeding before or during birth due to transfusion include:
   - Fetal to Maternal
   - Twin to Twin
   - Placenta Previa, Abruption
3. Suspected bleeding in the newborn is of the concern; the pediatrician approach the clinical problem in a systematic manner, as follows:
   - A bleeding in the newborn require preliminary laboratory evaluation.
   - The investigations assist with immediate management and determine the future health implications for the baby.
   - The clinical management include potential prevention, measures to ensure cardio respiratory stability, treatment of underlying problems and replacement of coagulation factors.
   - Situations that are complicated require investigation and management with consultation of a hematologist who may also assist in follow-up if ongoing problems are anticipated.
4. Seizure is a sudden, electrical impulse in the brain activity that will cause an involuntary movement like chewing or bicycling in newborn.
5. Seizures in neonates can involve these visible symptoms as follows:
   - Random roving eye movements where the eyelid blinking or fluttering is rapid, with eyes rolling up or eye opening to staring.
   - Obvious sucking, smacking, chewing and protruding of the tongue.
   - Untypical bicycling or pedaling movements of the legs.
   - Observational thrashing or struggling movements.
   - Visible long pauses in breathing (apnea).
   - Rhythmic jerking movements that may involve the muscles of the face, tongue, arms, legs or other regions of the body.
6. Common observations for newborn infants to refuse to breastfeeding are as follows:
   - Delivery that is a difficult labour.
   - Medication used during labour probably anesthesia, epidural or pethidine that makes the baby sleepy.
   - Possible discomfort due to a birth injury or bruising.

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- Obvious swallowing of mucus at birth and suctioning can make the infant feel congested, nauseous or uncomfortable.

7. Necrotizing Enterocolitis (NEC) is an unfavorable gastrointestinal complication in prematurely born infants.
8. A newborn baby's on time passage of the first stool is a sign of the well-being but a failure of a full-term newborn to pass meconium in the first 24 hours may signal intestinal obstruction. Lower intestinal obstruction requires a radiologic study to make the diagnosis.
9. There can be clinical defects in the urinary tract that can cause urine blockage:
   - Vesicoureteral Reflux (VUR)
   - Ureteropelvic Junction (UPJ) obstruction
   - Bladder Outlet Obstruction (BOO), such as Posterior Urethral Valves (PUV) ureterocele
   - Prune Belly Syndrome (PBS)
   - Esophageal Atresia (EA)
   - Congenital heart defects
10. Abdominal distention is seen in newborns is observed that can be life-threatening in certain cases. There is very less inforamtion available regarding early identification of the etiology of abdominal distention in newborn babies which is imperative to limiting the likelihood of serious consequences.
11. The reasons for abdominal distention are as follows:
    - Congenital malformations may be the major cause of abdominal distension in early newborns.
    - Sepsis and congenital megacolon are the single disease most frequently associated with abdominal distention in preterm and full-term newborns respectively.
    - Vomiting is a main accompanying symptom in early newborns with abdominal distention.

8.4 SUMMARY

- Newborn health may be at threat because of bleeding due to serious cardiovascular or neurological adversities.
- It is noted in a pediatric medical care the immediate administration of vitamin K reduces the incidence of hemorrhagic disease of the newborn but abnormal bleeding can occur in babies due to several possibilities.
- Bleeding in the newborn may be due to cardiovascular effects associated with a loss of blood or the damaging effects of bleeding on neonatal tissues probably in the brain.

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- A bleeding in the newborn require preliminary laboratory evaluation.
- The clinical management when a newborn is bleeding include potential prevention, measures to ensure cardio respiratory stability, treatment of underlying problems and replacement of coagulation factors.
- Seizure is a sudden, electrical impulse in the brain activity that will cause an involuntary movement like chewing or bicycling in newborn.
- Seizures have an underlying cause and if left untreated can cause permanent damage to the brain. Infants who have neonatal seizures may develop epilepsy, cerebral palsy, mental retardation and other neurological disorders later in life.
- Diagnosis and treatment of neonatal seizures involves experienced health care team to identify and treat the underlying cause of the seizures. Anticonvulsant medications may be prescribed by the pediatric team while monitoring the infant.
- Incase, the infant is suffering from a hypoxic ischemic encephalopathy which is a possibility of not receiving enough oxygen to the brain then the infant may receive hypothermia treatment to reduce brain damage which is obviously caused by the lack of oxygen. This hypothermic treatment will ease the cooling of the infant's brain and body by a few degrees immediately after birth for several hours or days.
- Breastfeeding may seem natural to some mother's but few babies struggle to latch on.
- Certain infants cannot comply to breastfeed and cry a lot as they find it difficult to latch on and are unable to nurse effectively at breast feeding.
- Feeding intolerance is possible among babies born preterm and showing signs of abdominal distension, vomiting, bilious gastric residuals and occult or gross bloody stools.
- Necrotizing Enterocolitis (NEC) is an unfavorable gastrointestinal complication in prematurely born infants.
- Due to expected lapse in coordination between sucking, swallowing and breathing, the infant are usually fed via an intragastric tube, through intermittent boluses or continuously.
- A newborn baby's on time passage of the first stool is a sign of the well-being but a failure of a full-term newborn to pass meconium in the first 24 hours may signal intestinal obstruction. Lower intestinal obstruction requires a radiologic study to make the diagnosis.
- Abdominal distention is seen in newborns is observed that can be life-threatening in certain cases.
- Congenital malformations may be the major cause of abdominal distension in early newborns.

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- Sepsis and congenital megacolon are the single disease and are most frequently associated with abdominal distention in preterm and full-term newborns respectively.
- Vomiting is also a main symptom in early newborns with abdominal distention.
- In newborns a distended bloated belly after feeding milk can be because the baby has swallowed excessive air during the feeding causing gas.
- The infant will be irritable and cry more than usual because of the discomfort in the belly and will pass more gas than usual, more burps, belch or pass gas excessively.

8.5 KEY WORDS

- **Seizure**: Seizure is a sudden, electrical impulse in the brain activity that will cause an involuntary movement like chewing or bicycling in newborn.
- **Necrotizing Enterocolitis**: Necrotizing Enterocolitis (NEC) is an unfavorable gastrointestinal complication in prematurely born infants.

8.6 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What are the possible reasons of bleeding before or during birth?
2. Expand the term HELLP. What is its history and physical examination?
3. What are the symptoms observed in a newborn when he get seizures?
4. How is neonatal seizures Diagnosed and treated?
5. What is abdominal distention and the reasons for abdominal distention?

Long-Answer Questions

1. Explain the reasons for bleeding, its symptoms and treatment in a sick newborn.
2. Discuss about seizures of sick newborn. How fatal can be these and how they are treated?
3. Elaborate a note about newborn refusal to eat, its cause and how it can be cured.
4. Discuss about abdominal distention of a newborn.
5. Analyse the reason why a sick newborn in unable to pass meconium and urine.

8.7 FURTHER READINGS

NOTES

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BLOCK - III
CLINICAL NUTRITION IN INFANTS

NOTES

UNIT 9 NUTRITIONAL MANAGEMENT IN MALNUTRITION AND OBESITY

Structure

9.0 Introduction
9.1 Objectives
9.2 Nutritional Management in Malnutrition
    9.2.1 Protein-Energy Malnutrition (PEM)
    9.2.2 Obesity in Children
    9.2.3 Rickets in Children
    9.2.4 Anemia in Children
    9.2.5 Scurvy
    9.2.6 Vitamin a Deficiency
9.3 Answers to Check Your Progress Questions
9.4 Summary
9.5 Key Words
9.6 Self Assessment Questions and Exercises
9.7 Further Readings

9.0 INTRODUCTION

Malnutrition refers to when a person's diet does not provide enough nutrients or the right balance of nutrients for optimal health. Malnutrition encompasses both over nutrition, associated with overweight and obesity, and undernutrition, referring to multiple conditions including acute and chronic malnutrition and micronutrient deficiencies. Malnutrition occurs when a person gets too much or too little of certain nutrients. Undernutrition occurs when they lack nutrients because they eat too little food overall. A person with undernutrition may lack Vitamins, minerals, and other essential substances that their body needs to function.

Causes of malnutrition include inappropriate dietary choices, a low income, difficulty obtaining food, and various physical and mental health conditions. Undernutrition is one type of malnutrition. It occurs when the body does not get enough food. It can lead to delayed growth, low weight, or wasting. If a person does not get the right balance of nutrients, they can also have malnutrition. It is possible to have obesity with malnutrition. When a person has too little food, a limited diet, or a condition that stops their body from obtaining the right balance of

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nutrients, it can have a severe impact on their health. In some cases, this can become life threatening.

Malnutrition increases the risk of infection and infectious disease, and moderate malnutrition weakens every part of the immune system. For example, it is a major risk factor in the onset of active tuberculosis. Protein and energy malnutrition and deficiencies of specific micronutrients increase susceptibility to infection. Malnutrition affects HIV transmission by increasing the risk of transmission from mother to child and also increasing replication of the virus. In communities or areas that lack access to safe drinking water, these additional health risks present a critical problem. Lower energy and impaired function of the brain also represent the downward spiral of malnutrition as victims are less able to perform the tasks they need to in order to acquire food, earn an income, or gain an education.

During growth years the requirement of nutrients usually is high and such demands need to be met adequately. Regular visits to the pediatrician for assessment of adequate growth in height and weight is essential. Malnutrition causes more problems in children than any other age group as they may lead to growth retardation and susceptibility to repeated infections. Children with Protein Energy Malnutrition (PEM) need to be identified. This includes children with Marasmus and Kwashiorkor. These children require aggressive therapy. Children with long term diseases need therapy for malnutrition as a prophylactic measure. This includes additional nutrients, Vitamins and mineral supplements, etc. The underlying disease also needs to be treated adequately to prevent malnutrition. Children with severe malnutrition need therapy in the hospital. This includes parenteral nutrition and slow introduction of nutrients by mouth. Once their condition stabilizes then they can gradually be introduced to a normal diet.

In this unit, you will study about nutritional management in malnutrition Protein–Energy Malnutrition (PEM), anemia, scurvy, rickets, Vitamin a deficiency, obesity of childhood.

9.1 OBJECTIVES

After going through this unit, you will be able to:

- Understand about nutritional management in malnutrition
- Explain about Protein–Energy Malnutrition (PEM)
- Discuss about anemia, scurvy, rickets, Vitamin A deficiency
- Analyse the cause of obesity in childhood

9.2 NUTRITIONAL MANAGEMENT IN MALNUTRITION

Malnutrition refers to the lack of sufficient nutrients in the body. Malnutrition occurs when the body does not get enough nutrients. Malnutrition occur due to poor diet,

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digestive conditions or another disease. Symptoms of malnutrition are fatigue, dizziness and weight loss. Untreated malnutrition can cause physical or mental disability.

Malnutrition is multifaceted. We face the dilemma of over nutrition seemingly encompassing concerns of overweight and obesity as well as under nutrition and associated multiple conditions including acute and chronic malnutrition as well as predominant micronutrient deficiencies.

What is chronic malnutrition? The chronic malnutrition is due to insufficient ingestion or mal-absorption of essential nutrients over a prolonged duration of period leading to clinically worrying visible concerns.

When we talk about malnutrition due to under nutrition it is responsible for causative stunting which is short stature for age. Amongst infants, the common indicator of chronic malnutrition is associated with developmental impairments and reduced productive potential later in life as adolescent and adult. Deficiency of micronutrient causes a chronic malnutrition that can impact health, development as well as productivity over the lifespan.

Although, visible signs may not be markedly seem but micronutrient deficiencies are often referred to as hidden hunger. The impact of chronic malnutrition when pronounced in the first years of life can affect the period of rapid growth and development. Acute malnutrition results from sudden reductions in food intake or diet quality and is often combined with pathological causes.

9.2.1 Protein-Energy Malnutrition (PEM)

Acute malnutrition can be defined with different conditions including Protein-Energy Malnutrition (PEM), wasting:

- Kwashiorkor
- Marasmus

Interchangeably, acute malnutrition and wasting are denoted together.

WHO 2012: Moderate Acute Malnutrition (MAM): Weight-for-height z-score between "2 and "3 or Mid-Upper: Severe Acute malnutrition (SAM): Weight for height z-score < "3 or MUAC < 115 millimeters, or the presence of bilateral pitting edema, or both.

GNC 2014: Global Acute Malnutrition (GAM): MAM and SAM accounted together where it is used as a measurement of nutritional status at a population level and as an indicator of the severity of an emergency situation.

Actually, marasmus and kwashiorkor are common terms that are used to differentiate between types of Severe Acute Malnutrition (SAM). To differentiate clinically, marasmus refers to children who are very thin for their height and do not have bilateral pitting edema and on the other hand kwashiorkor refers to edematous malnutrition in children.

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Risk Factors and Causes of Under Nutrition

In India the main reasons of under nutrition are:

- Poor dietary intake
- Inappropriate feeding
- Fetal growth restriction
- Lack of sanitation
- Insufficient of parental education
- Large family size
- Incomplete immunization
- Poverty
- Economic, political, and environmental instability and emergency situations.

Water, Sanitation and Hygiene (WASH)

A study conducted by Menon and his team in the year of 2013 in the country India demonstrated the impact of infant and young child feeding including factors as Water, Sanitation and Hygiene (WASH) on wasting. The remarkable observations indicated that improved dietary diversity and improved WASH were associated with better nutritional outcomes in children in India and it was concluded that integrated interventions targeted to both these risk factors would have a greater impact than single interventions.

In developing nations poverty is the primary major risk factor for wasting in infants as is a cause of inaccessibility to potable drinking water sources and lack of latrines. Economically disadvantaged families are less likely to have access to improved sources of drinking water, such as water from pipes or tube wells, and are less likely to have access to latrines especially in rural or urban slums. A study undertaken by researchers Cao, Wang, Zeng 2013 explain the correlation between fetal growth restriction and child wasting find scientific correlation that infants born small for gestational age or those with low birth weight were at a significantly increased risk of being significantly considered clinically wasted at the age of 24 month. Similarly, low birth weight was found to be a risk factor for SAM in children under age five years as observed by research in 2013 by scholars Laghari and team.

Prevention of acute malnutrition involves providing adequate nutrition and disease prevention strategies.

Key interventions to prevent the development of acute malnutrition include:

- Appropriate breastfeeding and complementary feeding practices.
- Disease prevention strategies are important in breaking the infection-malnutrition cycle particularly related to diarrhea and repeated respiratory infections.

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The scientific temperament dwells on strategizing an integrated approach to optimizing healthy growth in infants and children can have an important impact on reducing rates of wasting.

Therapeutic Foods for Preventing and Treating Acute Malnutrition

- Special Formulas Under Pediatric Guidance: Nutritional composition of commonly used, specially formulated foods for the prevention and treatment of acute malnutrition.
- Locally Produced Therapeutic Foods: Using homegrown seasonal fruits and vegetables, millets like ragi and amaranth, moringa and lentils, sattu, powdered makahna or rice puffs to create baby centric complementary foods is encouraged. Amylase Rich Foods prepared by sprouting grains and sun drying, roasting grinding in to fine powder are being encouraged as weaning foods by regional pediatric health care educators in India.

Strategies for Prevention

Strategies for the prevention of pediatric malnutrition require public health interventions that promote means to achieve optimal child growth and development. Table 9.1 below illustrates nutritional composition of commonly used, specially formulated foods for the prevention and treatment of acute malnutrition.

Table 9.1 *Nutritional Composition of Commonly Used, Specially Formulated Foods for the Prevention and Treatment of Acute Malnutrition*

	F75 (100 g milk powder)	F100 (100 g milk powder)	Plumpy'Sup (100 g)	Plumpy'Doz (100 g)	Plumpy'Nut (100 g)	Supercereal Plus (100 g dry matter)
Used for	SAM	SAM	MAM	MAM	MAM or SAM	Prevention of MAM
Recommended serving size (kcal/kg/d)	80–100	200	75	46.3 g/day	SAM: 200 MAM: 75	200 g/day
Macronutrients						
Energy (kcal)	446	520	520–550	534–587	520–550	410
Protein (g)	5.9	>13	12.6–15.4	13.4–17.7	13–16	>16.4
Lipid (g)	15.6	>26	31.5–38.6	26.7–39.1	26–36	>4.1
Minerals						
Potassium (mg)	775	1,100	980–1,210	660–870	1,100–1,400	140
Calcium (mg)	560	300	300–350	800–980	300–500	452
Phosphorus (mg)	330	300	300–350	530–660	300–600	232
Magnesium (mg)	50	80	80–100	115–140	80–100	—
Zinc (mg)	12.2	11	12–15	8.7	11–14	5

Note: — = not available; d = day; g = gram; kcal = kilocalorie; kg = kilogram; MAM = moderate acute malnutrition; mg = milligram; SAM = severe acute malnutrition.
Nutriset catalogs; Supercereal Plus from USAID specifications.

The country requires a public health task force that encourages productive strategies to promote appropriate breastfeeding and complementary feeding practices and have access to appropriate health care for the prevention and treatment of disease as well as improved sanitation and hygiene practices.

As micronutrient deficiencies are most commonly linked to stunted linear growth, these deficiencies can also contribute to wasting, through the vicious malnutrition infection cycle.

We know that undernourished children tend to be more susceptible to infections that are primary contributors to weight reduction through increased metabolism, as well as reduced nutrient intake and gut absorption.

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Multiple-micronutrient powders and single-nutrient supplements are used to augment the nutritional content of the home diet and are recommended.

In WHO 2012 recommendation, it is suggested that an energy intake of 25 kcal/kg/d in addition to the standard nutrient requirements of a non-malnourished child can support a reasonable rate of weight gain without promoting obesity.

Treatment of Severe Acute Malnutrition

The approaches to identification, referral and treatment of SAM cases have been evolving and a mix of programmatic approaches can be found globally. The WHO endorses community-based management of uncomplicated SAM and recommends that children with poor appetite, severe edema (Grade III), and any of the Integrated Management of Childhood Illness danger signs or medical complications be treated in inpatient facilities in accordance with their 10-step model. Table 9.2 below illustrates common medical complications in severe acute malnutrition.

Table 9.2 *Common Medical Complications in Severe Acute Malnutrition*

Medical complication	Case definition
Anorexia, poor appetite[a]	Child is unable to drink or breastfeed; failed RUTF appetite test.
Intractable vomiting[a]	Child vomits after every oral intake.
High fever	Child has high body temperature, or axillary temperature > 38.5°C, rectal temperature > 39°C.
Hypothermia	Child has low body temperature, or axillary temperature < 35.0°C, rectal temperature < 35.5°C.
Lower respiratory tract infection	Child has a cough with difficult breathing, fast breathing (if child is age 2–12 months: 50 breaths per minute or more; if child is age 12 months to 5 years: 40 breaths per minute or more), or chest indrawing.
Severe anemia	Child has palmar pallor or unusual paleness of the skin (compare the color of the child's palm with your own palm and with the palms of other children).
Skin lesion	Child has broken skin, fissures, flaking of skin.
Unconsciousness[a]	Child does not respond to painful stimuli (for example, injection).
Lethargy, not alert[a]	Child is difficult to wake. Ask the mother if the child is drowsy, shows no interest in what is happening around him or her, does not look at the mother or watch your face when talking, is unusually sleepy.
Hypoglycemia	There are often no clinical signs of hypoglycemia. One sign that does occur in a child with SAM is eyelid retraction: child sleeps with eyes slightly open.
Convulsions[a]	During a convulsion, child's arms and legs stiffen because the muscles are contracting. Ask the mother if the child had convulsions during this current illness.
Severe dehydration	Child with SAM has a recent history of diarrhea, vomiting, high fever or sweating, and recent appearance of clinical signs of dehydration as reported by the caregiver.

Note: °C = degrees centigrade; RUTF = ready-to-use therapeutic food; SAM = severe acute malnutrition.

The WHO Published a 10-Step Guide for Inpatient Management of Complicated SAM Cases

Following are the guidelines published by WHO for inpatient management of complicated SAM cases (Refer Figure 9.1):

- **Initial Treatment:** Hypoglycemia, hypothermia, dehydration, infections, and electrolyte imbalances are corrected, as are micronutrient deficiencies with the exception of iron deficiency.
- **Rehabilitation:** Electrolyte imbalances and micronutrient deficiencies continue to be corrected, and iron is added. Feeding is increased to stimulate catch-up growth, and children are prepared for discharge.
- **Follow-Up:** Increased feeding is continued to recover lost weight:
  - o During the initial treatment phase, frequent feeding is important to prevent both hypoglycemia and hypothermia.
  - o Feeding during the initial treatment phase should be approached cautiously because of the fragility of the child's physiological state. F75 should be given every 30 minutes for two hours, followed by F75 every two hours, day and night.

- o Breastfed children should be encouraged to continue breastfeeding.
- o Children with hypothermia should be rewarmed by being clothed, covered with a warmed blanket, placed near a heater or lamp, or placed on the mother's chest (skin-to-skin) and covered.
- o Dehydration should be treated following the WHO's 2013 guidelines; several key updates have been included. For example, dehydrated children who are not in shock should be rehydrated orally or by nasogastric tube using ReSoMal or half-strength WHO low-osmolarity oral rehydration solution with added potassium and glucose.
- o If the child has profuse watery diarrhea or suspected cholera he or she should be rehydrated with full-strength WHO low-osmolarity oral rehydration solution.
- o Children who are severely dehydrated or with signs of shock should be rehydrated intravenously, using half-strength Darrow's solution with 5 percent dextrose, Ringer's lactate solution with 5 percent dextrose, or, if neither is available, 0.45 percent saline with 5 percent dextrose WHO 2013.
- o Infections should be treated routinely upon admission by provision of a broad-spectrum antibiotic, and measles vaccination should be given for unimmunized children older than age six months.
- o Micronutrient deficiencies should be treated by giving Vitamin A (200,000 International Units (IU) for children older than age 12 months, 100,000 IU for children ages 6–12 months, and 50,000 IU for children ages 0–5 months), coupled with daily multivitamin, folic acid, zinc, and copper supplementation for at least two weeks.
- o Iron supplementation should only be given once children have begun gaining weight.

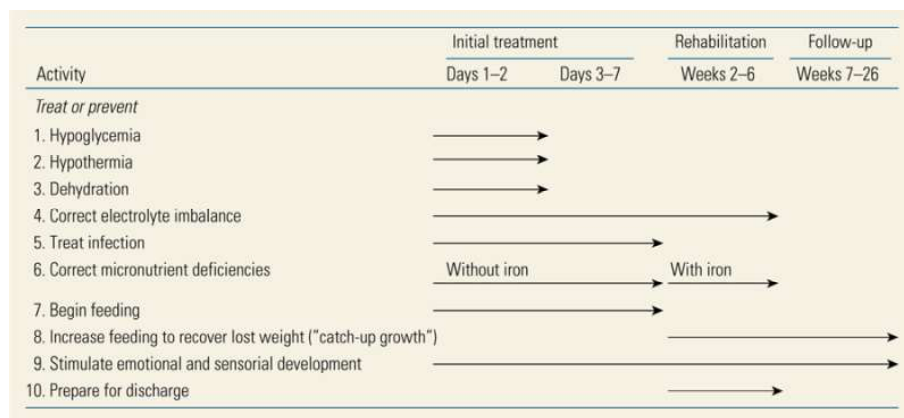


Fig. 9.1 *World Health Organization's 10-Step Plan for the Management of Severe Acute Malnutrition*

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Rehabilitation Phase

During the rehabilitation phase, F75 (feeding) should be replaced with F100 in the same amounts for 48 hours before increasing successive feeds by 10 milliliters until some remains unconsumed. If available, children could be transitioned from F75 to Ready-to-Use Therapeutic Food (RUTF) according to the updated WHO guidelines, 2013. Children's respiratory and pulse rates should be monitored closely. After transition to F100, children should receive feedings consisting of 100–200 kcal/kg/day and 4–6 g protein/kg/day at least every four hours. Breastfeeding should continue to be encouraged.

Follow-Up Phase

After recovery, parents should be taught to feed children frequently with energy- and nutrient-dense foods and to continue to stimulate their children's sensorial and emotional development. Parents should be requested to bring children back for regular follow-up checks. Vitamin A supplementation and booster immunizations should be provided.

9.2.2 Obesity in Children

Recent trends show that obesity in children is at an epidemic high in developed as well as in developing countries. Public health experts worry that children who are overweight or obese will have significant impact on both physical and psychological health. Overweight and obese children are likely to stay obese into adulthood and more likely to develop cardio metabolic conditions like diabetes and cardiovascular diseases at a younger age.

Wellness researchers are exploring reasons for obesity: environmental factors, lifestyle preferences, and cultural environment that are pivotal in the trending high prevalence of obesity all across. In general, the perception is that overweight and obesity are assumingly the results of an increase in caloric and fat intake.

On the other hand, there are supporting evidence that excessive sugar intake by soft drink, increased portion size, and steady decline in physical activity are contributing to the rising rates of obesity all around the world. Obesity in children can profoundly affect their physical health, social, and emotional well-being, and self esteem. Researcher's claim that it is also associated with poor academic performance in children in school. Comorbidities that are worrisome like metabolic, cardiovascular, orthopedic, neurological, hepatic, pulmonary, and renal disorders are also seen in association with childhood obesity.

Indian research study has defined overweight and obesity as overweight (between e”85^{th} and $<95^{th}$ percentile) and obesity (e”95^{th} percentile).

In the clinical environment, techniques, such as BMI, waist circumference, and skin-fold thickness have been used extensively to determine obesity in children. Although, BMI seems appropriate for differentiating adults, it may not be as useful in children because of their changing body shape as they progress through normal

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growth. In addition, BMI fails to distinguish between fat and fat-free mass (muscle and bone) and may exaggerate obesity in large muscular children. Furthermore, maturation pattern differs between genders and different ethnic groups. Studies that used BMI to identify overweight and obese children based on percentage of body fat have found high specificity (95–100%), but low sensitivity (36–66%) for this system of classification.

Causes of Childhood Obesity

Understanding that the increase in obesity results from an imbalance created between energy intake and expenditure there is also an indication of increasing evidence indicating that an individual's genetic background is important in determining obesity risk.

Researchers in child health have made important contributions to suggest that child risk factors for obesity include dietary intake, physical activity, and sedentary behaviour.

The impact of such risk factors is moderated by factors, such as age, gender. Family characteristics parenting style, parent's lifestyles also play a role. Environmental factors, such as school policies, demographics, and parents work-related demands further influence eating and activity behaviour.

Genetics are one of the biggest factors examined as a cause of obesity. Some studies have found that BMI is 25–40% heritable.

However, genetic susceptibility often needs to be coupled with contributing environmental and behavioural factors in order to affect weight. The genetic factor accounts for less than 5% of cases of childhood obesity. Therefore, while genetics can play a role in the development of obesity, it is not the cause of the dramatic increase in childhood obesity.

Basal metabolic rate has also been studied as a possible cause of obesity. Basal metabolic rate, or metabolism, is the body's expenditure of energy for normal resting functions. Basal metabolic rate is accountable for 60% of total energy expenditure in sedentary adults. It has been hypothesized that obese individuals have lower basal metabolic rates. However, differences in basal metabolic rates are not likely to be responsible for the rising rates of obesity.

Parenting is also a factor as a contributor to weight in children as they aptly learn by modeling parents and peer preferences accordingly decides on intake and willingness to try new foods. Nutritionists believe that:

- Availability and repeated exposure to, healthy foods is key to developing preferences and can overcome dislike of foods.
- Mealtime structure is important with evidence suggesting that families who eat together consume more healthy foods. Furthermore, eating out or watching TV while eating is associated with a higher intake of fat.
- Parental feeding style is also significant and authoritative feeding (determining which foods are offered, allowing the child to choose, and

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providing rationale for healthy options) is associated with positive cognitions about healthy foods and healthier intake. Interestingly authoritarian restriction of junk-food is associated with increased desire for unhealthy food and higher weight.

Government and social policies could also potentially promote healthy behaviour. Research indicates taste, followed by hunger and price, is the most important factor in adolescents snack choices.

Other studies demonstrate that adolescents associate junk food with pleasure, independence, and convenience, whereas liking healthy food is considered odd.

This suggests investment is required in changing meanings of food, and social perceptions of eating behaviour. As proposed by the National Taskforce on Obesity (2005), fiscal policies, such as taxing unhealthy options, providing incentives for the distribution of inexpensive healthy food, and investing in convenient recreational facilities or the esthetic quality of neighborhoods can enhance healthy eating and physical activity.

Excess Calories

1996-1998: A study examined children aged 9–14 and conclusively found that consumption of sugary beverages increased BMI by small amounts over the years. Sweetened beverages and soft drinks are contributing factor that has been examined as a potential contributing factor to obesity. Several studies on child wellness have examined the link between sugary drink consumption and weight and it has been continually found to be a contributing factor to being overweight. Sugary drinks offer no satiety and a quick liquid snack, which results in a higher caloric intake. Another factor that has been studied as a possible contributing factor of childhood obesity is the consumption of edible snack foods. Snack foods include foods, such as chips, baked goods, and candy. Many studies have been conducted to examine whether these foods have contributed to the increase in childhood obesity. While snacking has been shown to increase overall caloric intake, no studies have been able to find a link between snacking and overweight. Portion sizes have increased drastically in the past decade. Consuming large portions, in addition to frequent snacking on highly caloric foods, contribute to an excessive caloric intake. This energy imbalance can cause weight gain, and consequently obesity.

Activity Level

One of the factors is most significantly linked to obesity is a sedentary lifestyle and health promoters warning that each additional hour of television per day increased the prevalence of obesity by 2%.

Television viewing among young children and adolescents has increased dramatically in recent years.

The increased amount of time spent in sedentary behaviour has decreased the amount of time spent in physical activity. Research which indicates the number of hours children spend watching TV correlates with their consumption of the

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most advertised goods, including sweetened cereals, sweets, sweetened beverages, and salty snacks.

Despite difficulties in empirically assessing the media impact, other research discussed emphasizes that advertising effects should not be underestimated. Media effects have been found for adolescent aggression and smoking and formation of unrealistic body ideals. Regulation of marketing for unhealthy foods is recommended, as is media advocacy to promote healthy eating.

Environmental Factors

While extensive television viewing and the use of other electronic media has contributed to the sedentary lifestyles, other environmental factors have reduced the opportunities for physical activity. Opportunities to be physically active and safe environments to be active in have decreased in the recent years. The majority of children in the past walked or rode their bike to school. A study conducted in 2002 found that 53% of parents drove their children to school. Of these parents, 66% said they drove their children to school since their homes were too far away from the school. Other reasons parents gave for driving their children to school included no safe walking route, fear of child predators, and out of convenience for the child.

Children who live in unsafe areas or who do not have access to safe, well-lit walking routes have fewer opportunities to be physically active.

Socio-Cultural Factors

Socio-cultural factors have also been found to influence the development of obesity. Our society tends to use food as a reward, as a means to control others, and as part of socializing. These uses of food can encourage the development of unhealthy relationships with food, thereby increasing the risk of developing obesity.

Family Factors

Family factors have also been associated with the increase in cases of obesity. The types of food available in the house and the food preferences of family members can influence the foods that children eat. In addition, family mealtimes can influence the type of food consumed and the amount thereof. Lastly, family habits, whether they are sedentary or physically active, influence the child. Studies have shown that having an overweight mother and living in a single parent household are associated with overweight and childhood obesity.

Emotional Problems and Self Esteem

In one of the few studies to investigate the psychological impact of being overweight/obese in children, a review of 10 published studies over a 10-year period (1995-2005) with sample sizes greater than 50 revealed that all participants reported some level of psychosocial impact as a result of their weight status. Being younger, female, and with an increased perceived lack of control over eating seemed to heighten the psychosocial consequences.

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Consequences of Childhood Obesity

Childhood obesity can profoundly affect children's physical health, social, and emotional well-being, and self esteem. It is also associated with poor academic performance and a lower quality of life experienced by the child. These potential consequences are further examined in the following sections.

Medical Consequences

Childhood obesity has been linked to numerous medical conditions. These conditions include:

- Fatty Liver Disease
- Sleep Apnea
- Type 2 Diabetes
- Asthma
- Hepatic Steatosis (Fatty Liver Disease)
- Cardiovascular Disease
- High Cholesterol
- Cholelithiasis (Gallstones)
- Glucose Intolerance
- Insulin Resistance
- Skin Conditions
- Menstrual Abnormalities
- Impaired Balance
- Orthopedic Problems

Socio-Emotional Consequences

It is of concern that childhood obesity affects children's and adolescent's social and emotional health as being one of the most stigmatizing and least socially acceptable conditions in childhood. Overweight and obese children are often teased and/or bullied for their weight. They also face numerous other hardships including negative stereotypes, discrimination, and social marginalization.

The social consequences of obesity may contribute to continuing difficulty in weight management. Overweight children tend to protect themselves from negative comments and attitudes by retreating to safe places, such as their homes, where they may seek food as a comfort and avoiding play or exercise.

Academic Consequences

A research study shows that childhood obesity has also been found to negatively affect school performance.

The growing issue of childhood obesity can be halted, if family's focuses on the causes play into childhood obesity, some being more crucial than others. An

approach that combines diet and physical activity intervention all in the community and school is effective at preventing obesity or overweight.

Moreover, if parents enforce a healthier lifestyle at home, many obesity problems could be avoided. What children learn at home about eating healthy, exercising and making the right nutritional choices will eventually spill over into other aspects of their life.

9.2.3 Rickets in Children

Rickets is a condition that affects bone development in children. It causes bone pain, poor growth and soft, weak bones that can lead to bone deformities. Vitamin D Deficiency and rickets are two extensive conditions even in sunny regions like South Asia and the Middle East and commonly among migrant populations of India. This is probably due to dwindling time spent outdoors, increasing use of covering clothing, increasing sun screen usage, increasing pollution even in rural areas, beverages replacing milk intake all exacerbating pre-existing problems like darker skin pigmentation, little or no food fortification, poor intake of calcium and protein rich foods and interference of calcium absorption by dietary phytates.

According to wellness promoters and endocrinologists the poor musculoskeletal health a resultant of Vitamin D deficiency impacts the entire life cycle, with a Vitamin D deficient mother having a deficient newborn, who has poor bone mass accrual across childhood and adolescence, worsened by pregnancy for women and osteoporosis in old age.

Clinically diagnosed rickets is the tip of the iceberg, detected only in the most severe cases. Once we knew Vitamin D Deficiency causes rickets, early detection became possible, for which defining reference ranges for Vitamin D became important.

Historical data cannot be used for Vitamin D because assay type and quality have improved vastly. Therefore, deficiency is defined as the level of 25OHD3 below which a corrective PTH response is seen.

On this basis, all agree that for defining Vitamin D Deficiency, only 25OHD3 is useful; that other D metabolites are useful only in specific disease conditions and that 25OHD3 <10-12 ng/mL constitutes deficiency.

The Institute of Medicine (IOM) recommends that >20 ng/mL be considered sufficient, while the Endocrine Society recommends that this level be >30 ng/ml.

25OHD3 can be tested by different methods assays have improved in the last three decades. With the huge interest in Vitamin D Deficiency, assays have also become more easily and cheaply available, but testing remains tricky, and care in interpretation is needed.

All major societies recommend D supplementation for pregnant women, infants, and vulnerable children and adolescents; though doses and duration remain controversial. With greater awareness of how ubiquitous Vitamin D Deficiency is,

adherence to these recommendations is improving, but still woefully inadequate. The medical fraternity must be aware of the changing needs whether medical, environmental, or political.

NOTES

Rickets in growing children is possibly due to failure of mineralization of the growth plate and osteoid matrix. The bone matrix formation and mineralization is delay which causes an accumulation of unmineralized matrix on microscopic bone surfaces. The skeleton will succumb to losing its stiffness and becomes severely deformed with visible bowed legs and misshapen pelvis which in children ultimately leads to stunted growth. Clinical and radiological features of widened growth plates are usually used to diagnose rickets. The main causes of rickets are deficient intakes of Vitamin D and/or calcium, or physiological problems associated with the metabolism of these nutrients.

The peak incidence of rickets occurs among infants and young children aged 6–23 months and adolescents aged 12–15 years, though it may also occur in children aged between 2 years and 11 years.

Rickets in childhood is incomprehensible with sad consequences but is often poorly recognized by health systems and in society. It is associated mainly with:

- Growth Problems
- Bone Pain
- Muscle Weakness
- Limb And Pelvic Deformities
- Failure to Thrive
- Developmental Delay, such as Gross Motor Delays in Sitting
- Crawling and Walking and Dental Anomalies
- Poor Sleep and Restlessness
- Delay eruption of the deciduous teeth, which then alters the sequence of eruption, affecting mainly the permanent incisors, cuspids and first molars.

Progressing in to long term, rickets could lead to osteomalacia (abnormal matrix mineralization in established bone), low bone mass in adulthood and narrowing of the pelvic outlet, which then can result in obstructed labour and maternal and fetal death.

Nutritional Rickets

Vitamin D is a fat-soluble precursor of the steroid hormone 1, 25-dihydroxycholecalciferol 1, 25(OH)2 D or Vitamin D3. In skin, Vitamin D3 is formed in two steps, from 7-dehydrocholesterol into pre-vitamin D and then into Vitamin D3 upon exposure of skin cells to UltraViolet (UV) radiation from sunlight and subsequent conversion to pro-Vitamin D. In temperate climates, this only occurs during the summer months; at tropical latitudes, UVB at the appropriate wavelength is present year-round.

Vitamin D is also obtained from certain foods as Vitamin D3 (animal sources) or Vitamin D2 (plant sources), and in small quantities as 25 (OH) D, i.e., 25-hydroxyVitamin D.

Independent of the source (skin production or consumed from foods), Vitamin D is metabolized (hydroxylated) in the liver by 25-hydroxylase, to produce 25(OH) D (also called calcidiol).

Therefore, the level of 25(OH) D in the body reflects both Vitamin D intake and its endogenous production from sunlight. It is further metabolized into its active form, 1, 25 (OH)2 D, also referred to as calcitriol) in the kidneys for systemic actions, and in many organs and tissues, for mainly local effects (auto and paracrine actions).

Plasma 25(OH) D is considered to be the main bodily pool of Vitamin D, but both 25(OH) D and Vitamin D3 may be present in fat and muscle tissue. The levels of 25(OH) D mainly depend on supply (sun exposure and intake), while 1, 25 (OH)2 D is under strict hormonal control. The main function of active Vitamin D is to promote intestinal absorption of calcium and phosphate and, jointly with other hormones, to stimulate their renal re-absorption. Vitamin D also helps to maintain plasma calcium and phosphate at adequate levels to promote bone mineralization. At the same time, Vitamin D can help restore serum calcium and phosphate levels when they are low, by stimulating bone resorption in conjunction with PTH.

There are only a few foods that are naturally rich in Vitamin D, such as fatty fish and fish liver oils. Vitamin D is found in other foods, such as in beef liver, cheese and egg yolks, but only in small quantities.

In some countries, certain foods are mandatorily or voluntarily fortified with Vitamin D.

With infant formula milk, Vitamin D fortification is strictly controlled, with higher levels than in breast milk and other milk sources because of its lower bioavailability.

Either Vitamin D2 or Vitamin D3 may be added to foods but both interact with minerals and both degrade in the presence of moisture and oxygen. Commercially, a dry-stabilized form of the Vitamin is generally used in food fortification, which contains an antioxidant to protect the Vitamin in the presence of minerals. Fortification practices vary from country to country but the most common foods fortified with Vitamin D are milk and other dairy products, including dried milk powder, evaporated milk, margarines and vegetable oils.

Calcium intake in children with rickets is probably due to low calcium intake (below 300 mg/day), without Vitamin D deficiency resulting in rickets.

Rickets may also be caused by generalized poor nutrition or nutritional status, as this increase the risk of many nutrient deficiencies. In addition, the consumption of excessive amounts of fluoride or heavy metals, such as strontium, aluminum and

cadmium, which interfere with calcium and bone mineralization, may cause rickets. These minerals may be consumed from foods or drinking water. Treatment of nutritional rickets:

Supplementation with Vitamin D

WHO recognizes special situations in which Vitamin D supplementation may be needed. For example, it is recommended for very low-birth-weight infants at a dose ranging from 400 IU/day to 1000 IU/day (10–25 µg/day) until 6 months of age.

During emergencies, WHO recommends 200 IU (5 µg/day) Vitamin D as part of a multiple micronutrient supplement for pregnant women, lactating women and children aged 6–59 months. Various groups have suggested different Vitamin D regimens for the treatment of nutritional rickets.

The Lawson Wilkins Pediatric Endocrine Society recommends the following:

- Infants younger than 1 month: 1000 IU/day.
- Infants aged 1–12 months: 1000–5000 IU/day.
- Children older than 12 months: >5000 IU/day.
- When the condition is resolved, which usually occurs 3–4 months after treatment, a maintenance dose of 400 IU/day is suggested.

In settings of poor compliance maintenance dosing, it is suggested that single intermittent high doses be used.

The Global consensus recommendations on prevention and management of nutritional rickets suggested the following:

- Infants younger than 3 months.
- 2000 IU/day for 12 weeks, with a maintenance dose of 400 IU until the condition is resolved.
- Infants aged 3–12 months: 2000 IU/day for 12 weeks or a single dose of 50 000 IU, with a maintenance dose of 400 IU until the condition is resolved.
- Children aged 1–12 years: 3000–6000 IU/day for 12 weeks or a single dose of 150 000 IU, with a maintenance dose of 600 IU until the condition is resolved.
- Children older than 12 years: 6000 IU/day for 12 weeks or a single dose of 300 000 IU, with a maintenance dose of 600 IU until the condition is resolved.
- Monitoring of nutritional rickets after the onset.

9.2.4 Anemia in Children

Anemia is a condition in which the blood does not have enough healthy red blood cells. About 20% of children in the U.S. will be diagnosed with anemia at some

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point. A child who has anemia does not have enough red blood cells or hemoglobin. Hemoglobin is a type of protein that allows red blood cells to carry oxygen to other cells in the body. Nutritional anemia in children contains all pathological conditions in which the blood hemoglobin concentration drops to an abnormally low level, due to a deficiency in one or several nutrients.

The main nutrients involved in the synthesis of hemoglobin include:

- Iron
- Folic Acid
- Vitamin B

As per public health experts, iron deficiency is by far the first cause of nutritional anemia worldwide. Folic acid deficiency is less widespread and is often observed with iron deficiency. Vitamin B12 deficiency is far rarer.

Iron deficiency is probably abnormal iron biochemistry with or without the presence of anemia. Iron deficiency is usually the result of inadequate bio available dietary iron, increased iron requirement during rapid growth, and increased blood loss for any reason.

For infants and children the amount of iron is required for growth is quiet high substantially more iron must be absorbed than is lost from the body. For example, a one-year-old infant loses about 0.2 mg of iron/day, calculated on the basis of body surface area, from values measured in adults. The amount needed for growth averages roughly 0.6 mg. Consequently, about 75% of the 0.8 mg of absorbed iron needed per day during this period is for growth.

The three main reasons for iron deficiency anemia in children are:

- Poor bioavailability of iron consumed, related to the low consumption of absorption enhancers and a high consumption of absorption inhibitors in the second year of life.
- Insufficient intake of iron as compared to the need.
- Increased requirement during the rapid growth stage of infancy and early childhood, between six and twenty-three months.

Requirement of iron for prevention and treatment of iron deficiency anemia depends upon:

- The level of iron store for the child at the time of birth, which in turn depends on the iron status of the mother during pregnancy.
- Whether the child born is of low birth weight or normal birth weight.
- Whether the child is breast feeding exclusively, or with other foods, and if other foods, then whether they contain iron absorption inhibitors or iron absorption promoters.
- The quantity of food consumed and whether the bioavailability of iron from it is poor (5%) or good (up to 15%).

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How much Iron is Required?

For therapeutic purposes, an adequate and safe hematological response to oral iron intake can be achieved in four to six weeks with three milligrams of elemental iron / kilogram body weight /day.

In a prophylactic program, between one and two milligrams of iron/kg body weight/day is appropriate. Assuming five percent iron absorption, which is a very conservative estimate of absorption, a 12.5 mg dose is equivalent to 2.5 mg/kg body weight for a six month old child with an average weight of 5 kg; 1.6 mg/kg body weight for a 12 month old infant weighing 8 kg; and 1.2 mg/kg body weight for an 18-month-old infant weighing 12 kg.

The total iron requirement remains at 0.7 mg/per day for infants up to 18 months of age and is not dependent upon the body weight. Thus, the 12.5 mg dose would also meet almost 90% (assuming 5% of absorption from the dietary iron intake) of the estimated total iron requirement of children six to eighteen months old. Where the iron absorption is higher because of low iron stores, the upper safe limit of intake would not exceed with this dose. If compliance were poor, and children were dosed the equivalent of every other day between 35 – 45% of the iron requirement would be available from the iron supplement alone.

Efforts to Control Anemia among Children in India

The goals of the Government of India's tenth five-year plan for anemia control for children includes:

- Screening of children for anemia wherever required and appropriate treatment for those found to be anemic.
- Reducing the prevalence of anemia by 25% and moderate and severe anemia in children by 50%.

Unlike other countries where the policy refers to anemia control, but there is no specific intervention program, in India, the Nutritional Anemia Prophylaxis program is in existence since 1970.

As anemia has continued to be highly prevalent among children, the program has been re-designated as the National Nutritional Anemia Control Program in 1991.

This program aims at decreasing the incidence of anemia among the vulnerable sections of the population, namely pregnant and lactating women, IntraUterine Device (IUD) users, and children in the 1-5 year age group.

For children between 12 and 59 months the program prescribes one tablet of 20 mg elemental iron and to treat children found clinically anemic 100 g of folate for 100 days in a year.

9.2.5 Scurvy

Scurvy, a Vitamin C deficiency disease, is historical significant illness. It occurred in epidemic proportions in the past, especially on sea voyages, and with the

realization that its cure or prevention could be accomplished by oranges and lemons, it became an uncommon disease.

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Scurvy has not completely disappeared in the modern era, though. In children, it continues to be seen in certain high-risk groups, such as those with neuro-developmental disorders and those with poverty.

Underlying mechanism in these conditions is an extremely restricted diet. In infants, scurvy occurs because of the use of heated milk as heating destroys Vitamin C in the milk. Medical conditions, such as malabsorption, food allergies, and iron overload conditions, such as Thalassemia, renal failure, alcoholism, and malnutrition also predispose individuals to Vitamin C deficiency. Scurvy in children usually presents with musculoskeletal symptoms and signs.

Cutaneous signs include bleeding and swollen gums, petechiae/ ecchymoses, follicular hyperkeratosis, perifollicular hemorrhages, and corkscrew hair, and are very helpful in clinical diagnosis of scurvy. Characteristic radiographic findings and rapid amelioration of symptoms following specific treatment with Vitamin C confirm the diagnosis.

Serum or White Blood Cell (WBC) Vitamin C levels are helpful but not required for the diagnosis as the results are rarely available soon enough to guide treatment. Since scurvy is now encountered only rarely, awareness about its various clinical and radiographic findings has diminished. As a result, diagnosis of scurvy may be delayed or missed altogether resulting in unnecessary and potentially harmful diagnostic and therapeutic interventions.

Treatment is oral dietary Vitamin C, ascorbic acid. Scurvy may be avoided by adequate daily Vitamin C intake: infants 25 mg/day, children 30 – 40 mg/day, adults 40-75 mg /day. Intoxication does not occur as Vitamin C is not fat soluble.

Complications: Untreated, scurvy may result in failure to thrive, anemia, hypertension, and poor wound healing.

9.2.6 Vitamin a Deficiency

The main symptom of Vitamin A deficiency is vision loss and blindness and often begins as a problem adjusting to seeing in the dark, or night blindness. Children with night blindness do not see well in the dark and can see normally if enough light is present. As the Vitamin A deficiency worsens, the conjunctiva dries out and untreated it eventually leads to vision loss and blindness.

Diagnosis of Vitamin A Deficiency

Vitamin A deficiency is diagnosed by an eye exam and blood test to measure the amount of Vitamin A in the blood. Vitamin A deficiency is most common in rural areas or difficult geographical terrains with limited medical access; the diagnosis is often made informally. For example, a parent may mention their child's night blindness a common sign.

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Treatment of Vitamin A Deficiency

Vitamin A deficiency can be treated with Vitamin A supplements. The amount of supplements depends upon the age of the child. Vitamin A supplements can reverse night blindness. It can also help the eyes become lubricated again. But vision loss caused by scarring from corneal ulcers cannot be reversed.

There are organizations working to stop Vitamin A deficiency in developing nations. They promote prevention through a balanced diet and taking Vitamin supplements.

The diet in children and pregnant as well as lactating mothers should include dark green leafy vegetables, spinach, fenugreek, amaranth greens of carrots, turnip, cauliflower, moringa, deep bright colored fruits including papayas, oranges, carrots, beetroots, yellow vegetables like squash pumpkin. Vitamin A fortified milk and cereals, liver, egg yolks, and fish liver oils are helpful.

Carotenoids are absorbed better when consumed with some dietary fat. If milk allergy is suspected in infants, they should be given adequate Vitamin A in formula feedings.

In developing countries, prophylactic supplements of Vitamin A palmitate in oil 200,000 units (60,000 Retinol Activity Equivalent [RAE]) orally every 6 months are advised for all children between 1 and 5 years of age; infants < 6 months can be given a one-time dose of 50,000 units (15,000 RAE), and those aged 6 to 12 months can be given a one-time dose of 100,000 units (30,000 RAE).

Treatment of Vitamin A Deficiency

Conventional therapy of Dietary deficiency of Vitamin A involves giving palmitate in oil 60,000 units orally once a day for 2 days, followed by 4500 units orally once a day. If vomiting or malabsorption is present or xerophthalmia is probable:

- A dose of 50,000 units for infants < 6 months.
- 100,000 units for infants 6 to 12 months.
- 200,000 units for children > 12 months and adults should be given for 2 days.
- With a third dose at least 2 weeks later. The same doses are recommended for infants and children with complicated measles. As Vitamin A deficiency is known risk for severe measles the treatment with Vitamin A can shorten the duration of the disorder and may reduce the severity of symptoms and risk of death. It is recommended that all children with measles to be given 2 doses of Vitamin A (100,000 units for children < 12 months and 200,000 units for those > 12 months) given 24 hours apart.

- Infants who are born of HIV-positive mothers should receive 50,000 units (15,000 RAE) within 48 hours of birth.
- Prolonged daily administration of large doses, especially to infants, must be avoided because toxicity may result.
- For pregnant or breastfeeding women, prophylactic or therapeutic doses should not exceed 10,000 units (3000 RAE)/day to avoid possible damage to the fetus or infant.

Check Your Progress

1. Define malnutrition. How does it occur?
2. What is chronic malnutrition?
3. What does deficiency of micronutrients causes?
4. How is acute malnutrition caused?
5. Give any four reasons for under nutrition.
6. What happens in rehabilitation phase?
7. Define the term rickets.
8. Write in short about anemia.
9. Name the main nutrients involved in the synthesis of hemoglobin.
10. What are the main causes of iron deficiency anemia in children?
11. How does scurvy occur?
12. Give the main symptom of vitamin A deficiency.

9.3 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Malnutrition refers to the lack of sufficient nutrients in the body. It occurs when the body does not get enough nutrients.
2. The chronic malnutrition is due to insufficient ingestion or mal-absorption of essential nutrients over a prolonged duration of period leading to clinically worrying visible concerns.
3. Deficiency of micronutrient causes a chronic malnutrition that can impact health, development as well as productivity over the lifespan.
4. Acute malnutrition results from sudden reductions in food intake or diet quality and is often combined with pathological causes.
5. In India the main reasons of under nutrition are:
   - Poor dietary intake
   - Inappropriate feeding

- Fetal growth restriction
- Lack of sanitation

6. Key interventions to prevent the development of acute malnutrition include:
    - Appropriate breastfeeding and complementary feeding practices.
    - Disease prevention strategies are important in breaking the infection-malnutrition cycle particularly related to diarrhea and repeated respiratory infections.
    - During the rehabilitation phase, F75 (feeding) should be replaced with F100 in the same amounts for 48 hours before increasing successive feeds by 10 milliliters until some remains unconsumed. If available, children could be transitioned from F75 to Ready-to-Use Therapeutic Food (RUTF) according to the updated WHO guidelines, 2013. Children's respiratory and pulse rates should be monitored closely. After transition to F100, children should receive feedings consisting of 100–200 kcal/kg/day and 4–6 g protein/kg/day at least every four hours. Breastfeeding should continue to be encouraged.
7. Rickets is a condition that affects bone development in children. It causes bone pain, poor growth and soft, weak bones that can lead to bone deformities.
8. Anemia is a condition in which the blood does not have enough healthy red blood cells. About 20% of children in the U.S. will be diagnosed with anemia at some point. A child who has anemia does not have enough red blood cells or hemoglobin. Hemoglobin is a type of protein that allows red blood cells to carry oxygen to other cells in the body.
9. The main nutrients involved in the synthesis of hemoglobin include:
    - Iron
    - Folic Acid
    - Vitamin B
10. The three main reasons for iron deficiency anemia in children are:
    - Poor bioavailability of iron consumed, related to the low consumption of absorption enhancers and a high consumption of absorption inhibitors in the second year of life.
    - Insufficient intake of iron as compared to the need.
    - Increased requirement during the rapid growth stage of infancy and early childhood, between six and twenty-three months.
11. Scurvy, a Vitamin C deficiency disease, is historical significant illness. It occurred in epidemic proportions in the past, especially on sea voyages, and with the realization that its cure or prevention could be accomplished by oranges and lemons, it became an uncommon disease.

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12. The main symptom of Vitamin A deficiency is vision loss and blindness and often begins as a problem adjusting to seeing in the dark, or night blindness.

9.4 SUMMARY

- Malnutrition refers to the lack of sufficient nutrients in the body.
- Malnutrition occurs when the body does not get enough nutrients.
- Malnutrition occur due to poor diet, digestive conditions or another disease.
- Symptoms of malnutrition are fatigue, dizziness and weight loss.
- Untreated malnutrition can cause physical or mental disability.
- The chronic malnutrition is due to insufficient ingestion or mal-absorption of essential nutrients over a prolonged duration of period leading to clinically worrying visible concerns.
- Prevention of acute malnutrition involves providing adequate nutrition and disease prevention strategies.
- As micronutrient deficiencies are most commonly linked to stunted linear growth, these deficiencies can also contribute to wasting, through the vicious malnutrition infection cycle.
- During the rehabilitation phase, F75 (feeding) should be replaced with F100 in the same amounts for 48 hours before increasing successive feeds by 10 milliliters until some remains unconsumed. If available, children could be transitioned from F75 to Ready-to-Use Therapeutic Food (RUTF) according to the updated WHO guidelines, 2013.
- Childhood obesity can profoundly affect children's physical health, social, and emotional well-being, and self-esteem. It is also associated with poor academic performance and a lower quality of life experienced by the child.
- It is of concern that childhood obesity affects children's and adolescent's social and emotional health as being one of the most stigmatizing and least socially acceptable conditions in childhood.
- The social consequences of obesity may contribute to continuing difficulty in weight management.
- Overweight children tend to protect themselves from negative comments and attitudes by retreating to safe places, such as their homes, where they may seek food as a comfort and avoiding play or exercise.
- Rickets is a condition that affects bone development in children. It causes bone pain, poor growth and soft, weak bones that can lead to bone deformities.
- Rickets in growing children is possibly due to failure of mineralization of the growth plate and osteoid matrix.

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- The bone matrix formation and mineralization is delay which causes an accumulation of unmineralized matrix on microscopic bone surfaces.
- The main causes of rickets are deficient intakes of Vitamin D and/or calcium, or physiological problems associated with the metabolism of these nutrients.
- Vitamin D is a fat-soluble precursor of the steroid hormone 1, 25-dihydroxycholecalciferol 1, 25(OH)2 D or Vitamin D3.
- In skin, Vitamin D3 is formed in two steps, from 7-dehydrocholesterol into pre-vitamin D and then into Vitamin D3 upon exposure of skin cells to UltraViolet (UV) radiation from sunlight and subsequent conversion to pro-Vitamin D.
- Vitamin D is also obtained from certain foods as Vitamin D3, i.e., animal sources or Vitamin D2, i.e., plant sources, and in small quantities as 25 (OH) D, i.e., 25-hydroxyVitamin D.
- Anemia is a condition in which the blood does not have enough healthy red blood cells.
- A child who has anemia does not have enough red blood cells or hemoglobin.
- Hemoglobin is a type of protein that allows red blood cells to carry oxygen to other cells in the body.
- Nutritional anemia in children contains all pathological conditions in which the blood hemoglobin concentration drops to an abnormally low level, due to a deficiency in one or several nutrients.
- Iron deficiency is probably abnormal iron biochemistry with or without the presence of anemia.
- Iron deficiency is usually the result of inadequate bio available dietary iron, increased iron requirement during rapid growth, and increased blood loss for any reason.
- Scurvy, a Vitamin C deficiency disease, is historical significant illness. It occurred in epidemic proportions in the past, especially on sea voyages, and with the realization that its cure or prevention could be accomplished by oranges and lemons, it became an uncommon disease.
- Vitamin A deficiency is diagnosed by an eye exam and blood test to measure the amount of Vitamin A in the blood.
- Vitamin A deficiency is most common in rural areas or difficult geographical terrains with limited medical access; the diagnosis is often made informally.
- Vitamin A deficiency can be treated with Vitamin A supplements. The amount of supplements depends upon the age of the child.
- Vitamin A supplements can reverse night blindness. It can also help the eyes become lubricated again. But vision loss caused by scarring from corneal ulcers cannot be reversed.

- Carotenoids are absorbed better when consumed with some dietary fat. If milk allergy is suspected in infants, they should be given adequate Vitamin A in formula feedings.

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9.5 KEY WORDS

- **Malnutrition**: Malnutrition refers to the lack of sufficient nutrients in the body.
- **Scurvy**: Scurvy is a Vitamin C deficiency disease, is historical significant illness.
- **Rickets**: Rickets is a condition that affects bone development in children.
- **Anemia**: Anemia is a condition in which the blood does not have enough healthy red blood cells.

9.6 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What is malnutrition?
2. List the risk factors and causes of under nutrition.
3. Write a brief note on WASH.
4. What are the strategies for the prevention of pediatric malnutrition?
5. What is rehabilitation phase?
6. Distinguish between rickets and scurvy.
7. What is the main symptom of vitamin A deficiency?

Long-Answer Questions

1. Write a descriptive note on PEM.
2. Discuss about therapeutic foods for preventing and treating acute malnutrition.
3. Draw a table to show common medical complications in severe acute malnutrition.
4. What are the guidelines published by WHO for inpatient management of complicated SAM cases?
5. Discuss in detail about obesity in children, its causes and treatment.
6. What are the various consequences of childhood obesity?
7. Elaborate a note on rickets. Discuss how it is caused and treated.

8. How is anemia caused in children? What are the main nutrients involved in the synthesis of hemoglobin?
9. Discuss in detail about scurvy and its complications.
10. Explain how vitamin A deficiency is diagnosed and treated.

NOTES

9.7 FURTHER READINGS

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UNIT 10 NUTRITION FOR UNDERWEIGHT CHILD

NOTES

Structure

10.0 Introduction
10.1 Objectives
10.2 Underweight and Underweight Nutrition and its Short and Long Term Consequences in Infants
10.3 Answers to Check Your Progress Questions
10.4 Summary
10.5 Key Words
10.6 Self Assessment Questions and Exercises
10.7 Further Readings

10.0 INTRODUCTION

An underweight person is a person whose body weight is considered too low to be healthy. The Centers for Disease Control and Prevention (CDC) recommend people use a Body Mass Index (BMI) to calculate if they are underweight, at a healthy weight, or overweight. Using the BMI is considered a good measure of a person's weight because it compares their weight to their height. For example, a 170-pound person may not be overweight if they are very tall but could be overweight if they are very short.

Body fat percentage is another way to assess whether a person is underweight. Unlike the body mass index, which is a proxy measurement, the body fat percentage takes into account the difference in composition between adipose tissue (fat cells) and muscle tissue and their different roles in the body. The American Council on Exercise defines the amount of essential fat, below which a person is underweight, as 10–13% for women and 2–5% for men. The greater amount of essential body fat in women supports reproductive function. Using the Body Mass Index (BMI) as a measure of weight-related health, with data from 2014, age-standardised global prevalence of underweight in women and men were 9.7% and 8.8%, respectively. These values were lower than what was reported for 1975 as 14.6% and 13.8%, respectively, indicating a worldwide reduction in the extent of under nutrition.

A person may be underweight due to genetics, improper metabolism of nutrients, lack of food (frequently due to poverty), drugs that affect appetite, illness (physical or mental) or the eating disorder anorexia nervosa. Being underweight is

associated with certain medical conditions, including type 1 diabetes, hyperthyroidism, cancer, and tuberculosis. People with gastrointestinal or liver problems may be unable to absorb nutrients adequately. People with certain eating disorders can also be underweight due to one or more nutrient deficiencies or excessive exercise, which exacerbates nutrient deficiencies.

Being underweight can be a symptom of an underlying condition, in which case it is secondary. Unexplained weight loss may require a professional medical diagnosis. Being underweight can also cause other conditions, in which case it is primary. Severely underweight individuals may have poor physical stamina and a weak immune system, leaving them open to infection. People who are malnourished raise special concerns, as not only gross caloric intake may be inadequate, but also intake and absorption of other vital nutrients, especially essential amino acids and micronutrients, such as vitamins and minerals.

In women, being severely underweight, as a result of an eating disorder or due to excessive strenuous exercise, can result in amenorrhea (absence of menstruation), infertility or complications during pregnancy if gestational weight gain is too low. Malnourishment can also cause anemia and hair loss. Being underweight is an established risk factor for osteoporosis, even for young people. This is seen in individuals suffering from relative energy deficiency in sport, formerly known as female athlete triad: when disordered eating or excessive exercise cause amenorrhea, hormone changes during ovulation leads to loss of bone mineral density. After this low bone mineral density causes the first spontaneous fractures, the damage is often irreversible. Although being underweight has been reported to increase mortality at rates comparable to that seen in morbidly obese people, the effect is much less drastic when restricted to non-smokers with no history of disease, suggesting that smoking and disease-related weight loss are the leading causes of the observed effect.

In this unit, you will study about underweight and underweight nutrition and its short term and long term consequences in infants.

10.1 OBJECTIVES

After going through this unit, you will be able to:

- Understand what underweight is
- Explain about underweight nutrition
- Discuss about short and long term consequences in infants of underweight nutrition

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10.2 UNDERWEIGHT AND UNDERWEIGHT NUTRITION AND ITS SHORT AND LONG TERM CONSEQUENCES IN INFANTS

An underweight person is a person whose body weight is considered too low to be healthy. Undernutrition is defined by an insufficient provision of energy and nutrients, such as good quality protein with an adequate balance of essential amino acids, vitamins and minerals, and an inability to meet the requirements of the body to ensure growth, maintenance, and specific functions.

The National Family Health Survey collects data from 400,000 households is the chief source of health data in India that collates data on marriage, fertility, vaccinations, nutrition and health status, among other indicators.

In India, the nutritional level among children has been not optimistic over the last five years as per the recent collected health data. Statistics of the 22 states and Union Territories show a record high in the percentage of children under the age of five years who are either stunted, wasted and underweight that is measured within 2015-16 in the States Kerala, Gujarat, Maharashtra, Goa and Himachal Pradesh all of which had lowered their rates of stunting in the previous decade but have now reported a rise in stunted children in the fifth round of the NFHS (2019-20) survey.

It is disappointing to see that 16 states and UTs out of the 22 that were surveyed; records show a rise in the percentage of children under five years of age indicating observational severely wasting and were underweight in comparison to NFHS-4 as per the data information collected.

Public health experts worry that our nation India has a poor score on the global hunger index ranking just above 13 countries out of a total of 107. According to senior research fellow Miss Purnima Menon, senior research at the International Food Policy Research Institute this is the impact of the economic slowdown of the last few years and some of those economic shocks that the country has experienced and the 2020 pandemic crisis will make it worse. The report provided by World Bank in 2019 alarms India as being the second highest place holder of having stunted children in South Asia (at 38%), after Afghanistan (41%). Wasting is highest in India at 21%, followed by Sri Lanka at 15% and Bangladesh at 14%.

The three key indicators accounting for measuring child under-nutrition are as follows:

- Stunting (a lower-than-expected height for age).
- Wasting (lower-than-expected weight for height).
- Underweight (lower-than-expected weight for age).

NOTES

India being a developing country, may have observed a growth in the economy, the child mortality rate due to undernutrition is still high in both urban and rural areas.

The factors responsible for influencing nutritional status of the child in India are as follows:

- Gender of the child
- Birth order
- Exclusive breast feeding
- Economic status of the family
- Type of family
- Acute diarrhea
- Maternal education

UNICEF, 2006 report indicated the causes of childhood malnutrition are as follows:

- Insufficient diet
- Frequent infections
- Poor breastfeeding practices
- Delayed introduction of complementary foods
- Inadequate protein in the diet
- Other factors that influence food intake include health status, food taboos, growth and personal choice related to diet. Malnutrition can also develop due to neglecting, abnormal mealtimes, insufficient quantities of food and insufficient parental knowledge.

Every year International Food Policy and Research Institute (IFPRI) publish the Global Hunger Index (GHI). In Hunger Index 2020, India was ranked 94 among 107 countries in the Global and is in the serious hunger category with a score of 27.2. In the index, India features behind Nepal (73), Pakistan (88), Bangladesh (75) and Indonesia (70) among others (Refer Figure 10.1).

Prevalence of undernutrition among under five children according to the National Family Health Survey 4 (NFHS 4) in India shows that 35.7% under five children were underweight, 38.4% were stunted and 21% were wasted.

From National Family Health Survey 1 (NFHS 1) to National Family Health Survey 4, the prevalence of under nutrition has not declined as desired. According to the Comprehensive National Nutrition Survey report (2016–2018), 35% of Indian children aged 0–4 years were stunted, 17% were wasted and 33% were underweight.

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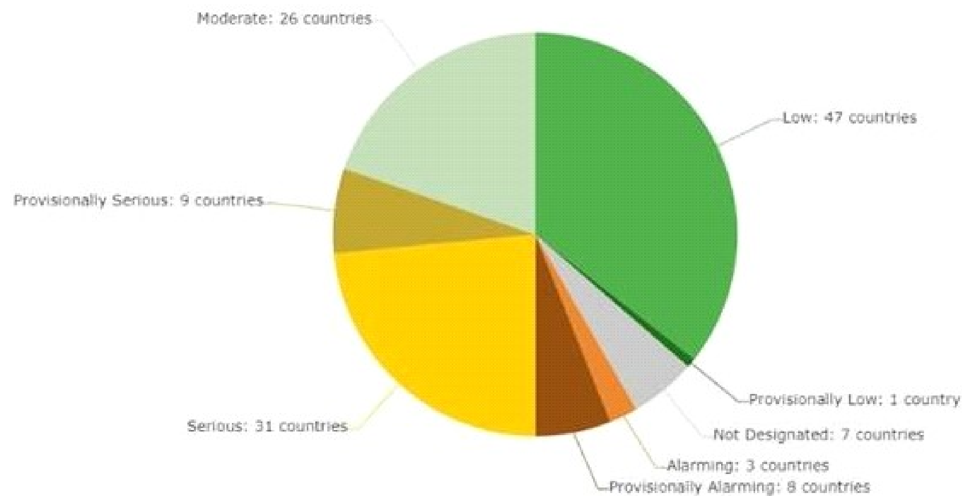


Fig. 10.1 *2020 Global Hunger Index Countries by Hunger Severity Designation*

Malnutrition in the form of under nutrition, namely underweight, stunting and wasting has been coined as the silent emergency by the United Nations children's fund.

Underweight: An underweight person is a person whose body weight is considered too low to be healthy. Being underweight can represent as many health concerns to an individual as being overweight can. If a person is underweight, their body may not be getting the nutrients it needs to build healthy bones, skin, and hair. While some people may have a genetic background or a medical illness that prevents them from putting on weight, there are interventions doctors can recommend to help a person gain weight.

Stunting: Stunting is when a child has a low height for their age, usually due to malnutrition, repeated infections, and/or poor social stimulation. This is a chronic condition that can occur if a child does not have access to the right nutrition – in particular during the crucial first 1,000 days of their life. Stunting not only affects a child's health, making them more susceptible to disease and infection, but also impairs their mental and physical development – meaning children who suffer from stunting are less likely to achieve their full height and cognitive potentials as adults.

Stunted growth is a reduced growth rate in human development. It is a primary manifestation of malnutrition (or more precisely undernutrition) and recurrent infections, such as diarrhoea and helminthiasis, in early childhood and even before birth, due to malnutrition during fetal development brought on by a malnourished mother. The definition of stunting according to the World Health Organization (WHO) is for the height for age value to be less than two standard deviations of the WHO Child Growth Standards median.

It is important to note that stunting is different from wasting. If stunting is a low height for a child's weight, wasting is low weight for a child's height.

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Wasting: Wasting is defined as low weight-for-height. It often indicates recent and severe weight loss, although it can also persist for a long time. It usually occurs when a person has not had food of adequate quality and quantity and/or they have had frequent or prolonged illnesses. Wasting in children is associated with a higher risk of death if not treated properly.

Wasting and stunting are often presented as two separate forms of malnutrition requiring different interventions for prevention and/or treatment. These two forms of malnutrition, however, are closely related and often occur together in the same populations and often in the same children. Wasting and stunting are both associated with increased mortality, especially when both are present in the same child.

The Government Of India (GOI) has strongly committed to achieving the 2030 Sustainable Development Goals (SDGs). End hunger, achieve food security and improved nutrition and promote sustainable agriculture, all these nutrition-related factors are included in Sustainable Development Goals (SDGs). If under nutrition is not effectively reduced, the country will not meet its SDG target of child mortality reduction.

In developing countries, the nutritional status of children depends on socio-economic status, awareness of diseases, such as diarrhea and acute respiratory tract infection, educational status of mother and availability of safe drinking water. Undernourished children are prone to infections. Statistically underweight children succumb to diseases, such as diarrhea, measles, and malaria and lower respiratory tract infections. Under nutrition in young children have long-term negative effects on physical and cognitive development.

A global review on child stunting and economic outcomes revealed 1 cm increase in height was associated with a 4% increase in wages for men and a 6% increase in wages for women. Investing in the reduction of child malnutrition is paramount for human and economic development.

Data from six longitudinal studies on the association between anthropometric status and mortality of children aged 6–59 months revealed a strong association between the severity of weight for age deficits and mortality rates. Indeed, out of the 11.6 million deaths among under-five children in 1995 in developing countries, it has been estimated that 6.3 million or 54% of young child mortality were associated with malnutrition.

Despite India's growth in the economy, the child mortality rate due to under nutrition is still high in both urban and rural areas. Hence, assessment of nutritional status among children is critical in framing health policies.

The majority of earlier studies on under nutrition were carried out either in the rural area or in the urban area, while few earlier studies focus only on chronic under nutrition, i.e., stunting. To bridge this gap, a study was conducted to assess the prevalence of under nutrition in children under five and its determinants in rural and urban areas of Maharashtra, India.

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Studies that were a large comparative study as compared to most of the studies in India among under five children of urban slum and rural area observed:

- Prevalence of stunting among children under five was 45.9%, wasting was 17.1 and 35.4% children were underweight.
- High prevalence of stunting (89.6%) and underweight (73.2%) were reported in a study among under five children in Uttar Pradesh, India.
- Wasting may result from inadequate food intake or a recent episode of illness-causing weight loss.
- The highest prevalence of wasting is in South Asia, where approximately one in six children (16%) are moderately or severely wasted. The burden of wasting is highest in India, which has more than 25 million (20%) children considered under wasting. This exceeds the combined burden of the next nine high-burden countries. Overall, 17% of Indian children age 0–4 years were considered with signs of wasting.
- Stunting reflects chronic under nutrition and hence UNICEF is also focusing on stunting among under five children.
- In a study, it was found that stunting was more prevalent in the urban slum (49.7%) as compared to rural area (42.1) whereas, according to Comprehensive National nutrition survey report (2016–2018) higher prevalence of stunting in under-fives was found in rural areas (37%) as compared to urban areas (27%).
- The availability of food grains is more or less uniform throughout the year in an urban slum. In rural area seasonal availability of food grains increases. There is a tendency to purchase only locally produced and available seasonal grains, vegetables, and fruits which are comparatively cheaper in rural areas. Hence, stunting is more prevalent in the urban area.

The socio-demographic characteristics of the child's family are associated with the presence of under nutrition. The possible risk factors include the:

- Gender of the child
- Birth weight
- Birth order
- Number of siblings
- Exclusive breastfeeding
- Immunization status
- Mother's education and occupation
- Family income
- Mother's knowledge about the timing of weaning and diet.

Pediatric health experts preach exclusive breastfeeding up to 6 months as it gives protection against wasting to children both from a rural area. Exclusive breastfeeding up to 6 months is a known protective factor against infection because it is rich in anti-infective factors that prevent respiratory infections and diarrheal diseases. Breastfeeding enhances the immunity of the child and it should be accompanied by timely weaning with complimentary foods. Convincing mothers in certain sections of community is essential to create awareness that exclusive breastfeeding beyond 6 months without supplementing diet will imply that the child is getting inadequate nutrition and become malnourished.

It is noted that childhood infections like diarrhea and acute respiratory tract infection are important causes of malnutrition among under five children in developing countries. As these are acute episodes, it results in immediate weight loss and the prevalence of wasting is found higher in under five children with acute diarrhoea especially in the rural area.

Birth order has always been an important determinant of under nutrition in the rural areas in India. In India teenage marriages are visible in remote living communities. There is link of early childbearing, low birth weight babies which results in developing long term under nutrition of the child. It was observed that the prevalence of stunting was more among boys as compared to girls in the urban slum.

As compared to children with birth order 2 or more than 2, children with birth order less than two were more likely to be stunted in the rural area.

On the other hand, family plays a pivotal role in health and disease. It is observed that the joint family gives protection against stunting to under-five children of the urban slum. This emphasizes the importance of a joint family in society. If both parents are working then sharing resources and responsibilities amongst family members can help parents reduce the economical and physical stress. Children also get more attention in the joint family with elders around in terms of food security and play time.

The socioeconomic status of the family is one of the important determinants of the wellbeing of children and health. Lower the socioeconomic status higher is the risk of under nutrition.

A supportive study done in India and Africa reveals that families with low economic status have a significant association with under nutrition. With the improvement in socioeconomic status under nutrition proportionately declines. It was observed that the low income of the family had resulted in underweight among children from an urban slum.

Maternal education is a pivotal marker in family and child's nutrition status quotient. It is observed that low maternal education was a risk factor for under nutrition among under five children of rural areas. A better qualified mother is directly correlated with decreased under nutrition in child. Mother is the primary

caregiver for the child and hence mother's awareness and skill set matters. Educated mothers are more reachable to available health services along with open to acceptance to utilize the same is better among them. Mother is also the first teacher of the child and hence mother and child are treated as one unit. Educated girls marry at slightly higher age comparative to less educated girls and accordingly late childbearing and have a fewer number of children.

According to World Health Organisation (WHO), malnutrition includes under-nutrition, wasting, stunting, being underweight, inadequate vitamins or minerals, being overweight, obesity and resulting diet-related non-communicable diseases. Malnutrition in children is clinically visible as deficiencies, excesses or imbalances in intake of energy and essential nutrients.

The global burden of malnutrition is unacceptably high, with nearly half of all deaths in children under five years linked to poor nutrition. While the Indian government is aiming at a $5 trillion (Rs 5 lakh crore) economy by 2024, the State of the World's Children 2019 report by UNICEF has shown that malnutrition has caused 69% of child deaths below the age of five in India. Every second child in that age group is affected by some form of malnutrition.

The report further states that almost two in three children between six months and two years of age are not given food that supports their rapidly growing bodies and brains. This puts these children at the threshold risk of:

- Visible poor brain development
- Cognitive weak learning
- Very low immunity
- Prone to disease due to increased infections
- Mortality

> …the State shall regard raising the level of nutrition and standard of living of its people and improvement in public health among its primary duties. <“ *Article 47, Constitution of India*

Over the last five decades, successive five-year plans have laid down policies and multi-sectoral strategies to combat nutrition-related public health problems. The right to freedom from hunger and malnutrition has been recognised and briefly discussed by the Supreme Court in several cases on the public distribution system filed by the People's Union for Civil Liberties.

National Human Rights Commission (NHRC) was set up through a statute in 1993. The NHRC, February 18, 2020: issued notice to the Uttar Pradesh government after taking cognizance of media reports on deaths due to malnutrition in several parts of the state. The commission saw this as a grave violation of the rights to livelihood, food and adequate medical care.

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Case Study: Uttar Pradesh

- Census 2011, population of nearly 22 crore, Uttar Pradesh: One of the most populous state in India.
- NITI Aayog Health Index Report, 2019: Uttar Pradesh was the worst performing state with regard to death caused due to malnutrition.
- NHFS 2015-16: BMI below normal is most evident in Bihar, Jharkhand, Madhya Pradesh and Uttar Pradesh.

Various government initiatives have been launched over the years seeking to improve nutritional status in the country. These include as follows:

- The Integrated Child Development Services (ICDS)
- The National Health Mission
- The Janani Suraksha Yojana (JSY)
- Indira Gandhi Matritva Sahyog Yojana (IGMSY)
- The Mid-Day Meal (MDM) Scheme
- National Food Security Mission (NFSM)
- 2013: Effort was made to address the hunger-nutrition challenge through the National Food Security Act. The law aims to ensure greater access to an adequate quantity of quality food at affordable prices.
- 2015 survey by Swaraj Abhiyan, a political organisation, reveals unsatisfactory progress in its implementation.
- Data samples collected from Uttar Pradesh show that at places experiencing famine-like conditions, barely half of the poor families had eaten any pulses in the 30 days preceding the survey.

Compounding other economic and political factors that abet deaths due to malnutrition are social and cultural challenges that tend to defeat the very purpose of a nutrition program.

India's huge population contains, such as diverse community of ethnic and regional groups, of whom over 200 million (16.6%) are classified as 'Scheduled Castes'. A plan, for instance (named Hausla Poshan Yojana) to provide nutritious food to pregnant women and malnourished children in Uttar Pradesh failed to even take off because there were supposed women beneficiaries who refused to consume the food prepared by anganwadi workers belonging to the scheduled caste community, who have been historically regarded as untouchables by the upper castes.

These issues will continue but existing initiatives, such as the Public Distribution System (PDS), Mid-day Meal Scheme, Integrated Child Development Services (ICDS), Village and Child Development Centres need to be reinforced with more vigour and endurance to nudge India our of hidden hunger and starvation.

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The affordability of nutritious diets in rural India, is written by a renowned economist Kalyani Raghunathan and researcher Derek D. Headey, along with senior researcher Anna Herforth. They submitted a paper that concludes: Malnutrition is endemic in India, based on information on rural food price and wages gleaned from the 2011 National Sample Survey. Among the indicated problems that lend themselves to the worrying diet scenario in rural India are low wages and the significant structural problems facing India's agricultural sector. In spite of costs of diet increasing in the period between 2001 and 2011, the researchers of the paper write that rural wages have also increased in that time. However, in absolute terms nutritious diets in 2011 were still expensive relative to unskilled wages, constituting approximately 50-60% of male and about 70-80% of female daily wages of MGNREGA workers. The researchers claim that considering the number of dependents in average rural household and other non-food expenses, 45-64% of the rural poor cannot afford a nutritious diet that meets India's national food-based dietary guidelines.

Therefore, there is an immediate public health need to create awareness of nutritional requirements in policy making and to shift India's existing food policies away from their heavy bias towards cereals. The approach of these academicians is to awaken the policy makers to focus on food items like dairy, fruit and vegetables and their feasible access among unskilled workers helps.

Children with Malnourishment or Under Nutrition

Indicators are used to measure an infant with the nutritional imbalance that are causative in under nutrition being assessed as underweight, wasting and stunting or being overweight. The child's growth is recognized as a key indicator of nutritional status along with health across communities in global population.

The percentage of children with a low height for age (stunting) reflects the cumulative effects of under nutrition and infections since and even before birth. This measure is interpreted as an indication of poor environmental conditions or long-term restriction of a child's growth potential. The percentage of children who have low weight for age (underweight) can reflect wasting, i.e., low weight for height, indicating acute weight loss, stunting or both. Thus, underweight is a composite indicator and may therefore be difficult to interpret.

Further understanding of these terms:

- Underweight: Weight for age < –2 Standard Deviations (SD) of the WHO Child Growth Standards median.
- Stunting: Height for age < –2 SD of the WHO Child Growth Standards median.
- Wasting: Weight for height < –2 SD of the WHO Child Growth Standards median.

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- Overweight: Weight for height > +2 SD of the WHO Child Growth Standards median.

The consequences and implication (short term or long term) of under nutrition on infants and children are as follows:

Underweight: The most convenient measurement of under nutrition in assessment of weight in children. There is clear correlation from all evidence collected from past and recent years across communities that the mortality risk of children being clinically marked as mildly underweight is increased, and severely underweight children are at even greater risk.

Stunting: Stunting is the impaired growth and development that children experience from poor nutrition, repeated infection, and inadequate psychosocial stimulation. Children are defined as stunted if their height-for-age is more than two standard deviations below the WHO Child Growth Standards median. The growth retardation in children as a result of nutrition deficit diet intake or probably recurrent infections will be at increased risk for chronic illness and mortality.

Stunting is generally due to long-term nutritional depletion in meals and will result in:

- Delayed Mental Development
- Poor School Performance
- Reduced Intellectual Capacity
  - All of these are seen as an economic burden on the nation as it will affect human resource potential and productivity at national level.
  - The female gender which sees long time deprivation of nutrition or born to underweight mothers result in women of short stature and pose greater risk for obstetric complications because of a smaller pelvis.
  - Small women are at greater risk of delivering an infant with low birth weight, contributing to the intergenerational cycle of malnutrition, as infants of low birth weight or retarded intrauterine growth tend be smaller as adults.

Wasting: Wasting is defined as low weight-for-height. It often indicates recent and severe weight loss, although it can also persist for a long time. It usually occurs when a person has not had food of adequate quality and quantity and/or they have had frequent or prolonged illnesses. Wasting in children is associated with a higher risk of death if not treated properly. Children with acute under nutrition due to insufficient food intake or a high incidence of infectious diseases most experientially diarrhea result in wasting that will impair the functioning of the immune system and increases the severity and duration of and susceptibility to infectious diseases and an increased risk for death.

Under nutrition the leading cause of underweight infants and children who are not provided with sufficient diet of energy and nutrients including good quality protein poultry, seafood from dairy and with an adequate balance of essential amino acids, vitamins and minerals and an inability to meet the requirements of the body to ensure growth, maintenance and specific functions.

Nutritional stunting because of poor living environments nearly affects 178 million children (<5 years) in developing countries and is the most prevalent form of nutritional deficit across the globe, corresponding to 24.1% of cases.

Nutritional stunting is a combination of many factors:

- Intra-uterine and maternal under nutrition.
- Inadequate quality or quantity of complementary foods during infancy.
- Impaired absorption of nutrients caused by intestinal infections and parasites.

Consequences of Under Nutrition

Studies indicate that undernourished children present altered function in the Growth Hormone (GH) and Insulin-like Growth Factor (IGF) axis, with a raised concentration of GH but decreased plasma levels of IGF-1. This may be caused by the resistance to GH induced by under nutrition in the liver, reducing the synthesis of IGF-1, which leads to an increase in plasma GH, because IGF-1 acts in the Central Nervous System (CNS) to control the synthesis of Growth Hormone (GH) via negative feedback.

Three factors appear to control the resistance to Growth Hormone (GH) in under nutrition:

- Elevated concentration of cortisol.
- Reduced concentration of insulin.
- Decrease in the amount of essential amino acids in the blood.

The reduction in the Insulin-like Growth Factor 1 (IGF-1) concentration is the main factor responsible for the slowed growth in undernourished children.

Insulin-like Growth Factor 1 (IGF-1) is also associated with the growth and differentiation of organs and has important effects on myelination in the brain because it stimulates an increase in the expression of genes associated with myelin and also causes an increase in the number of oligodendrocytes and neurons. GH and IGF-1 are also important in the development and normal functioning of the immune, reproductive and cardiovascular systems. Food intake and nutritional status are the main regulators of IGF-1, and due to this marked sensitivity, the assay of the blood concentration of IGF-1 can be employed as an indicator of the nutritional status in children with reduced growth and as an indicator of dietary protein quality.

Long-Term Consequences of Underweight/Stunting

The long-term deleterious consequences of underweight/stunting are mostly attributed to cortisol, in which the blood concentration is increased in under nutrition.

The elevated cortisol levels seen in under nutrition are secondary, at least in part, to the fall in the rate of metabolic clearance.

Stress may help to maintain the elevated concentrations, suppressing the circadian variation in cortisol secretion as a result of the persistent stimulation of the Hypothalamic Pituitary Adrenocortical (HPA) axis and the consequent hypersecretion of Corticotrophin Releasing Hormone (CRH) and Adrenocorticotropin Hormone (ACTH).

- Raised concentrations of cortisol and ACTH decrease insulin release.
- Promote resistance to its peripheral action.
- Favour hepatic gluconeogenesis and the production of glucose.
- Stimulate lipolysis and inhibit the IGF-1-dependent effects of GH on growth.

These factors lead to a conservation of substrates and promote stunting.

The short term implication of this hormonal profile is considered to be a survival strategy that leads to a redirecting of body energy flow, favouring more important tissues, such as the nervous system and the liver in detriment to lean mass and adipose tissue. When the situational conditions are such that the consumption of energy and nutrients is insufficient or inadequate, the metabolism of the child will be such that the body prefers to reduce growth, energy expenditure and fat oxidation but to increase weight gain.

The changes in body composition that favour the accumulation of body fat in undernourished individuals become evident in adolescence. There is also an important negative impact of under nutrition underweight stunting on bone growth and bone mineral density in children.

A high prevalence of arterial hypertension has been found in children, adolescents and adults with nutritional stunting.

Under nutrition stunting in children has been linked to poor mental development and school achievement, and behavioral abnormalities in children. The essence of these observations is that under nutrition may not necessarily lead to death but has very negative consequences on individual health and standard of living individual throughout the life cycle.

Under nutrition is caused by poverty and disease, mainly diarrhoea, respiratory infections and parasites, associated with inadequate food consumption

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during growth, i.e., insufficient energy, good quality protein with balanced essential amino acids, vitamins and minerals (Refer Figure 10.2).

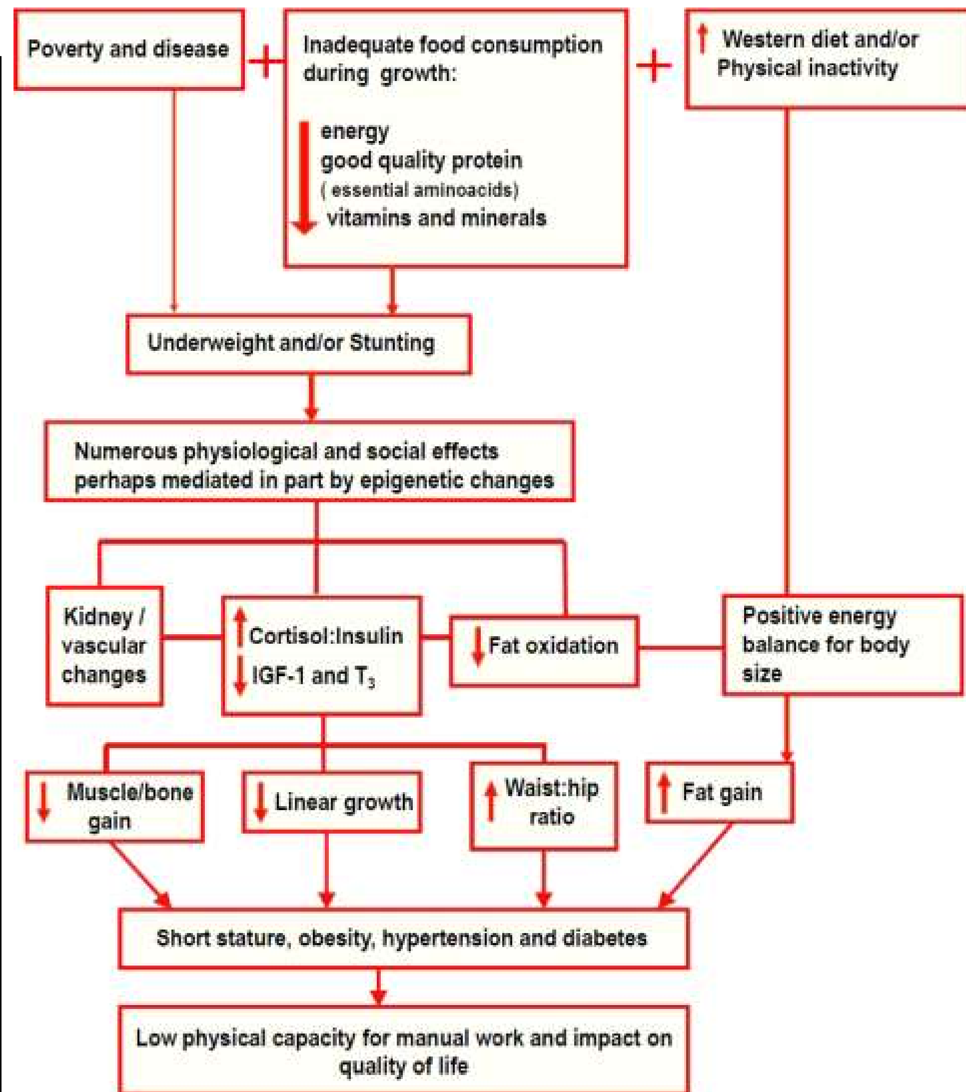


Fig. 10.2 *Association between Short Stature, Obesity, Hypertension, Diabetes and Work Capacity*

Nutrition Recovery

The maternal under nutrition has prime impact on fetal development and long term health trend of child. This acknowledgement is of importance to public health nutrition. Nationwide, programs and policies are designed to prevent under nutrition in maternal and infants and these programs are promoted at preliminary levels of public health system.

One of the biological variables with the greatest impact on the long-term health of undernourished children is the recovery of stature. For this reason, special attention to the quality of the diet during nutritional recovery is fundamental,

especially the quality of protein and the essential amino acids consumed, to enable a gain in stature without an unwanted increase in energy provision that might favour the later development of obesity.

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Check Your Progress

1. What is underweight?
2. How is undernutrition described?
3. List the key indicators accounting for measuring child under-nutrition.
4. Give the factors responsible for influencing nutritional status of the child in India.
5. What are the various government initiatives launched over the years that seek improvement in nutritional status of the country?
6. What are the main causes of stunting?
7. List the factors included in nutritional stunting.
8. Give the factors that appear to control the resistance to Growth Hormone (GH) in under nutrition.
9. What is the main reason for slowed growth in undernourished children?
10. What are the long-term deleterious consequences of underweight/stunting?

10.3 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. An underweight person is a person whose body weight is considered too low to be healthy.
2. Undernutrition is defined by an insufficient provision of energy and nutrients, such as good quality protein with an adequate balance of essential amino acids, vitamins and minerals, and an inability to meet the requirements of the body to ensure growth, maintenance, and specific functions.
3. The three key indicators accounting for measuring child under-nutrition are as follows:
   - Stunting (a lower-than-expected height for age).
   - Wasting (lower-than-expected weight for height).
   - Underweight (lower-than-expected weight for age).
4. The factors responsible for influencing nutritional status of the child in India are as follows:
   - Gender of the child
   - Birth order

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- Exclusive breast feeding
- Economic status of the family
- Type of family
- Acute diarrhea
- Maternal education

5. Various government initiatives have been launched over the years seeking to improve nutritional status in the country. These include as follows:
   - The Integrated Child Development Services (ICDS)
   - The National Health Mission
   - The Janani Suraksha Yojana (JSY)
   - Indira Gandhi Matritva Sahyog Yojana (IGMSY)
   - The Mid-Day Meal (MDM) Scheme
   - National Food Security Mission (NFSM)
6. The growth retardation in children as a result of nutrition deficit diet intake or probably recurrent infections will be at increased risk for chronic illness and mortality. Stunting is generally due to long-term nutritional depletion in meals and will result in:
   - Delayed mental development
   - Poor school performance
   - Reduced intellectual capacity
7. Nutritional stunting is a combination of many factors:
   - Intra-uterine and maternal under nutrition.
   - Inadequate quality or quantity of complementary foods during infancy.
   - Impaired absorption of nutrients caused by intestinal infections and parasites.
8. Three factors appear to control the resistance to Growth Hormone (GH) in under nutrition:
   - Elevated concentration of cortisol.
   - Reduced concentration of insulin.
   - Decrease in the amount of essential amino acids in the blood.
9. The reduction in the Insulin-like Growth Factor 1 (IGF-1) concentration is the main factor responsible for the slowed growth in undernourished children.
10. The long-term deleterious consequences of underweight/stunting are mostly attributed to cortisol, in which the blood concentration is increased in under nutrition.

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10.4 SUMMARY

- An underweight person is a person whose body weight is considered too low to be healthy.
- Undernutrition is defined by an insufficient provision of energy and nutrients, such as good quality protein with an adequate balance of essential amino acids, vitamins and minerals, and an inability to meet the requirements of the body to ensure growth, maintenance, and specific functions.
- In India, the nutritional level among children has been not optimistic over the last five years as per the recent collected health data.
- It is disappointing to see that 16 states and UTs out of the 22 that were surveyed; records show a rise in the percentage of children under five years of age indicating observational severely wasting and were underweight in comparison to NFHS-4 as per the data information collected.
- India being a developing country, may have observed a growth in the economy, the child mortality rate due to undernutrition is still high in both urban and rural areas.
- Every year International Food Policy and Research Institute (IFPRI) publish the Global Hunger Index (GHI).
- In Hunger Index 2020, India was ranked 94 among 107 countries in the Global and is in the serious hunger category with a score of 27.2. In the index, India features behind Nepal (73), Pakistan (88), Bangladesh (75) and Indonesia (70) among others.
- Prevalence of undernutrition among under five children according to the National Family Health Survey 4 (NFHS 4) in India shows that 35.7% under five children were underweight, 38.4% were stunted and 21% were wasted.
- Malnutrition in the form of under nutrition, namely underweight, stunting and wasting has been coined as the silent emergency by the United Nations children's fund.
- The government of India has strongly committed to achieving the 2030 Sustainable Development Goals (SDGs). End hunger, achieve food security and improved nutrition and promote sustainable agriculture, all these nutrition-related factors are included in Sustainable Development Goals (SDGs).
- If under nutrition is not effectively reduced, the country will not meet its SDG target of child mortality reduction.
- Investing in the reduction of child malnutrition is paramount for human and economic development.

NOTES

- Despite India's growth in the economy, the child mortality rate due to under nutrition is still high in both urban and rural areas. Hence, assessment of nutritional status among children is critical in framing health policies.
- The socioeconomic status of the family is one of the important determinants of the wellbeing of children and health.
- According to World Health Organisation (WHO), malnutrition includes under-nutrition, wasting, stunting, being underweight, inadequate vitamins or minerals, being overweight, obesity and resulting diet-related non-communicable diseases.
- Malnutrition in children is clinically visible as deficiencies, excesses or imbalances in intake of energy and essential nutrients.
- Indicators are used to measure an infant with the nutritional imbalance that are causative in under nutrition being assessed as underweight, wasting and stunting or being overweight.
- The child's growth is recognized as a key indicator of nutritional status along with health across communities in global population.
- The percentage of children with a low height for age (stunting) reflects the cumulative effects of under nutrition and infections since and even before birth. This measure is interpreted as an indication of poor environmental conditions or long-term restriction of a child's growth potential.
- The percentage of children who have low weight for age (underweight) can reflect wasting, i.e., low weight for height, indicating acute weight loss, stunting or both.
- The growth retardation in children as a result of nutrition deficit diet intake or probably recurrent infections will be at increased risk for chronic illness and mortality.
- Children with acute under nutrition due to insufficient food intake or a high incidence of infectious diseases most experientially diarrhea result in wasting that will impair the functioning of the immune system and increases the severity and duration of and susceptibility to infectious diseases and an increased risk for death.
- Studies indicate that undernourished children present altered function in the Growth Hormone (GH) and Insulin-like Growth Factor (IGF) axis, with a raised concentration of GH but decreased plasma levels of IGF-1.
- The reduction in the Insulin-like Growth Factor 1 (IGF-1) concentration is the main factor responsible for the slowed growth in undernourished children.
- Insulin-like Growth Factor 1 (IGF-1) is also associated with the growth and differentiation of organs and has important effects on myelination in the brain because it stimulates an increase in the expression of genes associated with myelin and also causes an increase in the number of oligodendrocytes and neurons.

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- The long-term deleterious consequences of underweight/stunting are mostly attributed to cortisol, in which the blood concentration is increased in under nutrition.
- A high prevalence of arterial hypertension has been found in children, adolescents and adults with nutritional stunting.
- Under nutrition is caused by poverty and disease, mainly diarrhoea, respiratory infections and parasites, associated with inadequate food consumption during growth, i.e., insufficient energy, good quality protein with balanced essential amino acids, vitamins and minerals.

10.5 KEY WORDS

- **Underweight**: An underweight person is a person whose body weight is considered too low to be healthy.
- **Undernutrition**: Undernutrition is defined by an insufficient provision of energy and nutrients, such as good quality protein with an adequate balance of essential amino acids, vitamins and minerals, and an inability to meet the requirements of the body to ensure growth, maintenance, and specific functions.
- **Stunting:** Stunting is the impaired growth and development that children experience from poor nutrition, repeated infection, and inadequate psychosocial stimulation.
- **Wasting:** Wasting is defined as low weight-for-height. It often indicates recent and severe weight loss, although it can also persist for a long time.

10.6 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What is underweight and underweight nutrition?
2. List the factors that are responsible for influencing nutritional status of the children.
3. What the causes of childhood malnutrition given by UNICEF?
4. Distinguish between stunting and wasting.
5. What are the consequences of under nutrition?
6. How is nutrition recovery done in under nutrition children?

Long-Answer Questions

1. Discuss about underweight, its causes and consequences.

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2. Explain about underweight nutrition in detail.
3. Discuss how children with malnourishment or under nutrition are treated?
4. Draw a well labelled diagram to show the association between short stature, obesity, hypertension, diabetes and work capacity.
5. Discuss about the short and long term consequences in infants of underweight nutrition.

10.7 FURTHER READINGS

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UNIT 11 NUTRITIONAL MANAGEMENT OF DIARRHOEA, TYPHOID, TUBERCULOSIS AND HEPATITIS OF INFANTS

Structure

11.0 Introduction
11.1 Objectives
11.2 Nutritional Management of Diarrhoea, Typhoid, Tuberculosis and Hepatitis for Infants
 11.2.1 Nutritional Management of Diarrhoea
 11.2.2 Nutritional Management of Typhoid
 11.2.3 Tuberculosis (TB) In Infants
 11.2.4 Nutritional Management of Hepatitis
11.3 Answers to Check Your Progress Questions
11.4 Summary
11.5 Key Words
11.6 Self Assessment Questions and Exercises
11.7 Further Readings

11.0 INTRODUCTION

Diarrhoea is defined as the frequent passage of watery, loose stools, accompanied by an excessive loss of fluid and electrolytes. Another standard definition of diarrhoea is passing more than three liquid bowel movements daily, or more than one liter of stool from an ileostomy or colostomy per day. Diarrhoea occurs because the contents of the gastrointestinal tract are moving too rapidly, causing less fluid and nutrients to be absorbed. The primary objective of feeding should always be to minimize the adverse effects of the illness on nutritional status. A secondary objective is to promote normal intestinal mucosal renewal and absorptive and digestive functions. The objectives of therapy are the same whether it is provided at home, in a community health clinic, or in a hospital. Although more complex individualized dietary treatment might be available in a hospital, the therapeutic principles are similar in all settings.

Typhoid is one of the most prevalent transmittable ailments that are spread through food and water contamination. It is a type of fever caused by the bacteria *Salmonella Typhi*, which attacks certain parts of our digestive tract and leads to ulcers along with a number of other signs and symptoms. Due to lower immunity

levels, children are often more susceptible to typhoid and sometimes they remain carriers of the disease even after recovery. Symptoms normally begin between 6 and 30 days after exposure to the bacteria. The two major symptoms of typhoid are fever and rash. Typhoid fever is particularly high, gradually increasing over several days up to 104 degrees Fahrenheit, or 39 to 40 degrees Celsius. The rash, which does not affect every patient, consists of rose-coloured spots, particularly on the neck and abdomen.

Malnutrition and tuberculosis are both problems of considerable magnitude in most of the underdeveloped regions of the world. It is important to consider, how these two problems tend to interact with each other. The term consumption has been virtually synonymous with tuberculosis throughout the history and the link between tuberculosis and malnutrition has long been recognized; malnutrition may predispose people to the development of clinical disease and tuberculosis can contribute to malnutrition. Before the advent of antituberculosis chemotherapy, a diet rich in calories, proteins, fats, minerals, and vitamins was generally considered to be an important, if not essential factor in treatment of tuberculosis. The introduction of specific antituberculosis drugs, however, has so radically altered the management of the disease that the role of diet should be considered in the light of the advances in treatment.

Hepatitis is an inflammation of the liver that results in diffuse hepatic cell death and may lead to areas of liver necrosis. It can be classified as acute or chronic lasting > 6 months and may progress to fulminant liver failure, cirrhosis, and, in some cases, hepatocellular carcinoma. Hepatitis may result from infectious and noninfectious causes. Viral hepatitis is most commonly caused by hepatitis virus and herpes virus. Common symptoms include fever, nausea, vomiting, fatigue, jaundice, right-upper-quadrant abdominal tenderness, and dark urine and pale stools.

In this unit, you will study about nutritional management of diarrhoea, typhoid, Tuberculosis (TB) and hepatitis of infants.

11.1 OBJECTIVES

After going through this unit, you will be able to:

- Understand the nutritional management of diarrhoea
- Explain how nutrition is managed in typhoid and Tuberculosis (TB)
- Discuss about hepatitis of infants

11.2 NUTRITIONAL MANAGEMENT OF DIARRHOEA, TYPHOID, TUBERCULOSIS AND HEPATITIS FOR INFANTS

The requirements of growth and organ development create a challenge in nutritional management of newborn infants. The stress of critical illness further complicates the delivery of adequate nutrients. Enteral feeding has several advantages over Parenteral Nutrition (PN), such as preservation of the gastrointestinal mucosa and decreasing the occurrence of sepsis related to bacterial translocation. Although feeding through the gastrointestinal tract is the preferred route for nutritional management, there are specific instances when PN as an adjunctive or sole therapy is necessary to meet nutritional needs. When meticulous attention is paid to the requirements of fluid, calorie, protein, and fat along with monitoring the metabolic status of patients, it is possible to provide full nutritional support for critically ill newborn infants.

11.2.1 Nutritional Management of Diarrhoea

Diarrhoea is the frequent passing of loose, watery and unformed faeces. In infants, mortality is associated with acute diarrhoea primarily due to the clinical dehydration that results from the loss of excessive body water and electrolytes in the stool. Although, in most cases the water and electrolytes replenishment is done orally but in certain cases intravenous therapy may be necessary to prevent serious complications or death. To prevent dehydration in children willing and able to drink will be rehydrated orally with Oral Rehydration Therapy (ORT).

The oral rehydration solution formula recommended by the World Health Organization (WHO) in millimoles per liter:

- Sodium 90
- Chloride 80
- Potassium 20
- Glucose 111
- Citrate Tribasic or Bicarbonate 30

After completing the rehydration, hydration needs to be maintained during continuing diarrhoea by alternating between the oral solution and water. Water can be provided by breast-feeding on demand or by giving plain water equal to about 50% of the volume of the oral solution administered, i.e., 2 parts of Oral Rehydration Therapy (ORT) solution to 1 part water or breast milk.

At home, if Oral Rehydration Solution (ORS) formula is not there then it can be made with the ingredients present in the kitchen, i.e., salt and a source of glucose found in the kitchen. The source of glucose is usually the everyday refined

household sugar or properly finely prepared rice powder as these appear to be better in facilitating the absorption of electrolytes and water.

Certain studies show reductions in stool output and duration of diarrhoea when rice powder which contains glucose, amino acids, and oligopeptides or soy is used as a substrate solution to prepare rehydrate. It has been demonstrated that the addition of an amino acid, such as glycine, to the standard glucose-electrolyte oral rehydration solution decreases duration of diarrhoea and fecal fluid losses. Rice powder and other cereals or soy are theoretically advantageous, because they contain amino acids or carbohydrate in the form of glucose chains, each of which promotes sodium transport. Additionally, as glucose is in the form of starch, more can be given without increasing the osmolarity. The upper limit of starch content has not yet been defined.

Infants below the age group of 6 months of age do not have a completely developed gut and lack of pancreatic amylase, due to this reason the infant cannot completely digest these starches.

If an improved ORT solution containing multiple water-soluble, organic molecules becomes available, it could increase the absorption of sodium and water and decrease the volume and duration of diarrhoea.

The small proportions of patients who have severe dehydration and shock, or who are unable to drink require immediate intravenous therapy. The intravenous fluid should be administered rapidly, to reverse shock within 1 hour and to correct the estimated volume deficit within 2–4 hours. It should contain enough potassium and base to correct hypokalemia and acidosis.

Persistent vomiting is often given as a reason for withholding ORT solutions, but vomiting usually stops in the first 4 hours if ORT solutions are judiciously used.

Nutritional Therapy

The main objective of nutrition therapy in infant with diarrhoea is to minimize the adverse effects of the chronic loose motions and infection on nutritional status of the infant. The clinical objective is to ensure normal intestinal mucosal regeneration and restore the absorptive and digestive functions.

- Feeding should not dominate the necessity to maintain fluid balance.
- Water and electrolytes must be included in the assessment of nutrient needs. Prime goal is proper rehydration, the first therapeutic tool.
- Only after the hydration status is stable within a few hours the dietary intake of the child can be resumed

Therapy need is to provide the child with nutrients to meet all the increased demands of body during the infection and help in the catch-up growth additionally attending to the usual nutrient requirement for maintenance, growth and physical activity.

As a pediatric nutritionist one needs to acknowledge that the choice of foods, medium of meal preparation, and frequency of feeding depends on the age of the child along with the feeding history, and physiologic status. Particular attention should be given to the nutrient density of the food used, the quality of its carbohydrate and fat, the biologic value of its protein, and, if appropriate the osmolarity. There are times when the need for specific nutrient supplements also must be considered.

Family's socio-cultural factors are considered important determinants of the management of diarrhoea. The food intake of the infant should not be stopped to stop loose motions as it ultimately leads to failure to compensate due to decrease in calorie intake during illness. This is a major contributor to the adverse nutritional effects of diarrhoea in addition to household fallacies like withholding of particular foods and breast feeding during and after diarrhoea.

- Breast-feeding should be encouraged for a child less than 6 months old as nutritional deficits can be corrected with breast milk alone.
- For infants older than 6 months of age the breast-feeding should be continued, but should be complemented with other foods.
- The quality of the mixture of dietary proteins should be considered in selecting foods either to complement breast milk or to provide all a child's nutrient intake. Protein quality should be assessed on the basis of digestibility and the balance of essential amino acids, which are determinants of the efficiency with which the protein is used for maintenance and growth.

Nutrition Advice

Animal protein is more easily digestible and is of higher biologic quality than plant protein. However, processing techniques can be used to improve digestibility of vegetable protein and proteins from different sources can be mixed to improve their combined food value.

The value of wheat-flour protein is inferior to that of case in dairy, but their combination in approximately of equal proportions, i.e., 55% wheat, 45% casein has a value equivalent to that of 100% casein; the protein value of a corn and black bean mixture (equal proportions) is substantially higher than that of either component; and the value of a mixture of corn and milk proteins (equal proportions) is higher than that of either component. Clinical and dietetic personnel must be encouraged to identify locally available foods that can be combined to increase food value economically like dal and rice gruels or ragi malt or rice kanji in whey water.

Allergenic proteins specific to cow's milk, can easily irritate the gut lining and sensitize a child. Understanding the infant's gut health and accordingly planning diet is necessary.

Dietary fat should supply about 40–50% of dietary energy during the first 6 months of life and approximately 35–40% for the remainder of early childhood. As the fat content falls further and further below the recommended proportions, the quantity of food needed to supply appropriate amounts of energy becomes excessively large; that progression increases the risk that energy intake will be inadequate. Vegetable fats that include relatively high proportions of unsaturated fat or fats of medium chain length are recommended for the first 6 months of life and are preferred during the early phases of treatment for diarrhoea, because they are generally more digestible and absorbable than highly saturated, long-chain fats. Plant-seed oils, for example corn and soy are relatively high in unsaturated fats, including the essential fatty acids. In contrast, coconut oil is more saturated and contains relatively high proportions of medium-chain-length fats, but contains practically none of the essential fatty acids. Although sufficient information is not available to make specific recommendations, a combination of unsaturated fats and mixed long-chain saturated fats should lead to better absorption than saturated fats alone. Although malabsorption of fats does not appear to exacerbate diarrhoea, it does prolong nutritional rehabilitation and adversely affects the retention of nitrogen when protein intake is marginal. Carbohydrates usually account for 35–55% of dietary energy during early infancy.

The principal types of dietary carbohydrate are starches and the disaccharides sucrose and lactose. Although the feeding of lactose to infants with gastroenteritis might be considered unwise, because of the recognized loss of intestinal lactase activity during intestinal infection, this type of acquired lactase deficiency is seldom total. Lactose at a concentration equivalent to that of half-strength cow's milk is generally well tolerated in diarrhoea, especially in mixed foods, such as milk and cereal combinations. Sucrose, the other major dietary disaccharide, and processed vegetable starches usually are easily digested and absorbed by children with diarrhoea. The potentially adverse effects of dietary carbohydrate can be minimized by multiple feedings of small amounts of mixtures of carbohydrates. This strategy is the least likely to strain possibly decreased capacity for carbohydrate digestion.

The potential for carbohydrate intolerance should be carefully addressed in clinical protocols prepared for primary health care workers. Misconceptions about transient intolerance to carbohydrate all too often lead to prolonged withholding of food. As a practical matter, if single challenges with lactose-containing foods do not aggravate clinical symptoms, continued tolerance during convalescence may be assumed.

Food Preparation for Infants having Diarrhoea

Important points to reinforce in preparation of food - consistency, digestibility, and acceptability are as follows:

- Watery gruels or thin vegetable soups can be given but should not be much diluted and excessively bulky foods need to be avoided as primary nutrient sources if possible.

- When formulated appropriately, watery gruels or soups can be used as adjuncts to fluid and electrolyte therapy, but never as a complete diet, because the concentrations of energy and nutrients in these preparations are usually too low.
- Local food-processing techniques should be used whenever possible, because of their familiarity to the population. For example, the digestibility of legumes can be improved through familiar cooking, fermenting, or germinating techniques that are not ordinarily used for infant feeding; particle size can be reduced by using simple food mills.
- If it is desirable to reduce lactose content and dairy will not be tolerated but partially fermented products, such as yogurt and whey water, can be used.
- Mixing dried-milk preparations with vegetables or cereals also reduces the lactose content of the final diet potentially without reducing the biologic value of the milk protein substantially.
- The kitchen is used of freshly prepared foods is encouraged to minimize microbial contamination should be encouraged. Reoffering of previously prepared food to infants might be unavoidable, but reheating to a boil before feeding will reduce the hazards of consuming heavily contaminated food and mother needs to be taught.

Frequency and Progression of Feeding

Lactation describes the secretion of milk from the mammary glands and the period of time that a mother lactates to feed her young. Lactation needs to be encouraged in breast fed infants, even during rehydration, by alternating between oral rehydration solutions and breast milk. Research has shown that breast-feeding is an effective adjunct to ORT and offsets the need to provide plain water. Meals that are offered should be small and frequent in the early phase, because smaller meals are better tolerated. For older infants, at least six feedings a day should be attempted early in treatment; more frequent feedings are often necessary in younger infants.

When children are hospitalized it is expected they might refuse to eat, it is reasonable to consider continuous nasogastric feeding. This approach takes full advantage of residual digestive and absorptive capacities through the slow, steady introduction of small quantities of food. It should be acknowledged that nasogastric feeding might increase stool frequency without markedly increasing stool volume.

Pediatric care team should teach every mother basic facts about rehydration and feeding to encourage participation in her infant are health care and recovery. A mother needs to recognize the importance of feeding during diarrhoea and to continue feeding during future episodes.

At times nutrition therapy failure is possible in children who may be moderately to severely malnourished. These children require correction in salt and water deficits but clinically hypokalemia, common in undernourished children, might

persist for several days. Potassium-containing foods, such as citrus juices and soft ripe bananas are useful adjuncts to oral rehydration.

Acknowledging food intolerance in infant once feeding is initiated after rehydration is necessary and is common in infants as they will refuse to eat, probably there is extensive vomiting after eating, and increased stool output which are signs of food intolerance.

Persistent clinical symptoms of abdominal distention, painful gas and explosive diarrhoea are important signs of food intolerance in the infant and are indicator that the carbohydrates being fed should be changed or reduced. In case, there is presence of undigested food particles in the stool, the mother needs to ensure that food is prepared with longer cooking time, try to use of refined raw materials and feeding more finely pureed foods.

Dietary Management in the Infant with Diarrhoea

Following are the methods of managing diet in infants suffering from diarrhoea:

- Discontinuation of feeding is not encouraged.
- Mandate feeding in children needs to be continued even during diarrhoea if their intake and weight gain are appropriate.
- It is noted that continuum feeding in infants will improve absorptive capacity, as substrates needed for tissue repair are provided and the treatment of diarrhoea might require the introduction of simpler, more easily digested foods.
- Importantly, serious diarrhoea requires fluid replacement with either oral rehydration solution or intravenous fluids and the diet should not be changed too often. Clinically takes 2–3 days for assessment and for natural diarrhoea process to abate and any complications of feeding to become apparent.

11.2.2 Nutritional Management of Typhoid

Typhoid is a bacterial infection that can lead to a high fever, diarrhea, and vomiting. In our nation, typhoid fever is endemic due to pertinent causative agent *Salmonella Typhi*. Typhoid and paratyphoid fevers is clubbed together under the collective term enteric fever. Typhoid fever is an acute, life-threatening, febrile illness. Typhoid fever symptoms may show after 7-14 days after ingestion of the microbe contaminated food or water. The symptoms develop visibly often appearing one to three weeks after exposure to the disease. The fever pattern is characterized by increasing temperature over the duration of each day that drops by the subsequent morning.

The clinical presentation of typhoid fever is seen from a mild illness with:

- Low Grade Fever
- Headache
- Fatigue

- Malaise
- Loss of Appetite
- Cough, constipation and skin rash or rose spots to in some cases, fatal complications, such as intestinal perforations, gastrointestinal hemorrhages, encephalitis and cranial neuritis.

In the initial course of the infection, the child is likely to experience:

- Fever that starts low and increases daily, possibly reaching as high as 104.9 degree F (40.5 degree C)
- Headache
- Coated Tongue
- Weakness and Fatigue
- Muscle Aches
- Sweating
- Dry Cough
- Loss of appetite and Weight Loss
- Abdominal Pain
- Diarrhoea or Constipation
- Rash
- Abdominal Distention

Treatment of Typhoid

Typhoid can be treated in the following way:

- Antipyretics.
- Adequate rest, hydration, correction of fluid-electrolyte imbalance.
- Adequate nutrition: a soft, easily digestible diet should be continued unless the patient has abdominal distension or ileus.
- In case of severe illness monitor blood pressure, blood sugar, electrolytes, hemoglobin, platelet counts and liver functions as indicated.
- Empiric treatment:
  - o Antibiotic treatment should be started as soon as possible to prevent complications, relapse, and the development of chronic carriage.
  - o Typhoid is usually treated with a single agent antibiotic.

The Food Plan in Typhoid Diet for a Child

Following is the food plan for typhoid diet for a child:

- Encourage breast feeding for an infant under 6 months of age as it is safe and hygienic.

- Mother should take care of her personal hygiene and her lactation diet.
- Children above the age of 6 months given complementary diet which is high in calories as there is weight loss due to illness progressing typhoid.
- Soft diet including mashed boiled potatoes or soft mashed ripe bananas, boiled mashed rice can be given to the child.
- These carbohydrates provide energy and are low in fiber hence do not cause gastric irritation.
- Supplementing with good quality protein like soft boiled egg whites or fresh curd is essential to meet the protein demands for the child.
- Rehydration is essential and making vegetable soups or lentil soups, rice kanji are suggested by nutritionists for infants to meet demands of fluids and electrolytes.

11.2.3 Tuberculosis (TB) In Infants

Tuberculosis (TB) is a contagious infection that usually attacks your lungs. It can also spread to other parts of your body, like your brain and spine. A type of bacteria called *Mycobacterium tuberculosis* causes it. In developing nation with high density of people living in close community in India, Despite the burden of both malnutrition and tuberculosis in children worldwide, there are few studies on the mechanisms that underlie this relationship. From available research, it appears that malnutrition is a predictor of tuberculosis disease and is associated with worse outcomes. This is supported through several lines of evidence, including the role of vitamin D receptor genotypes, malnutrition's effects on immune development, respiratory infections among malnourished children, and limited work specifically on pediatric tuberculosis and malnutrition. Nutritional supplementation has yet to suggest significant benefits on the course of tuberculosis in children. There is a critical need for research on childhood tuberculosis, specifically on how nutritional status affects the risk and progression of tuberculosis and whether nutritional supplementation improves clinical outcomes or prevents disease.tuberculosis remains a significant reason of illness amongst children in financial limited settings.

Reports indicate that from 9 million new tuberculosis infections each year at least 11% are children. It is observed that children living in tuberculosis endemic countries, malnutrition is also highly prevalent in children living in tuberculosis endemic countries and contributes to 2.2 million deaths in children fewer than 5 years of age globally.

The infection risk factors of TB are: poverty, overcrowding, food insecurity and Human Immunodeficiency Virus (HIV).

World Health Organization (WHO, indicates that malnutrition is a significant risk factor for childhood tuberculosis but there are numerous challenges in diagnosing pediatric tuberculosis.

Evidence indicates that genes related to vitamin metabolism contribute to susceptibility to tuberculosis specifically; vitamin D provides an exciting example of how genetics may underlie risk of tuberculosis disease.

Nutrition in Child with Tuberculosis Disease

Malnutrition is considered a contributor of tuberculosis and progression in children. Clinically, nutritional supplementation may improve immune function and clinical outcomes in tuberculosis but there has been limitation in the scientific results.

Table 11.1 *Summary of Micronutrients Important for Immunity against Tuberculosis*

Name	Function	Supplementation for Childhood Tuberculosis
Vitamin D	Macrophage function, proper phagocytosis, lysosomal fusion	Radiological improvement, but no difference in serum levels or weight change
Vitamin A	Regulates innate immunity, T and B lymphocyte function, and maintains mucosal epithelium	No improvement in weight or respiratory symptoms
Vitamin E	Antioxidant properties that may reduce oxidative stress on T lymphocytes	When included in a multivitamin for children, did not improve weight gain
Selenium	Cell and humoral immunity, utilized in creation of metalloenzymes.	No known studies in children
Iron	Innate immunity, such as neutrophil and natural killer function, T-cell maturation, and deficiency can result in shift toward Th2 response	No known studies in children

In summary, there is not sufficient evidence to support the use of macro or micronutrient supplementation for children with active tuberculosis in this tenure. However, diet practitioners emphasize on lactation and protein rich diet during tuberculosis to prevent muscle wasting and encourage healing in infants/children combating tuberculosis.

11.2.4 Nutritional Management of Hepatitis

Nutritional Needs and Support for Children with Chronic Liver Disease

Christine H. Yang *et al*, showed that the liver plays a crucial role in many of the body's metabolic processes, including regulating protein, fat, and carbohydrate metabolism; vitamin storage and activation; and detoxification and excretion of waste products. A general survey was conducted where viral hepatitis was the most common cause of neonatal onset chronic liver disease, followed by metabolic disorders and biliary atresia while a study in India found metabolic disorders to be the most common cause of chronic liver disease in children.

Children are particularly susceptible to malnutrition due to their high energy needs for growth. Approximately 25% of children diagnosed with chronic liver disease globally are undernourished, with the incidence being very high in developing nations.

Hepatitis in Children

Hepatitis is an inflammation of the liver. It can damage and destroy liver cells. Hepatitis is caused by being exposed to a virus that causes it. These viruses include:

- **Hepatitis Viruses:** There are 5 main types of the hepatitis virus: A, B, C, D, and E.
- **Cytomegalovirus (CMV):** This virus is a part of the herpes virus family.
- **Epstein-Barr Virus:** The virus causes mononucleosis.
- **Herpes Simplex Virus:** Herpes can affect the face, the skin above the waist, or the genitals.
- **Varicella Zoster Virus (Chickenpox):** A complication of this virus is hepatitis. But this happens very rarely in children.
- **Enteroviruses: Enteroviruses** is a group of viruses often seen in children. They include coxsackieviruses and echoviruses.
- **Rubella: Rubella** is a mild disease that causes a rash.
- **Adenovirus: Adenovirus** is a group of viruses that causes colds, tonsillitis, and ear infections in children. They can also cause diarrhoea.
- **Parvovirus: Parvovirus** virus causes fifth disease. Symptoms include a slapped-cheek rash on the face.

Conditions can also cause hepatitis in children. These can include autoimmune liver disease. For this disease, your child's immune system makes antibodies that attack the liver. This causes inflammation that leads to hepatitis.

Hepatitis A: Hepatitis A virus is passed through fecal-oral contact of contaminated food or water.

Hepatitis B: Hepatitis B is spread when blood from an infected person enters another person's body and infants may get from infected mother during pregnancy or during blood transfusions/dialysis or infected syringes.

Hepatitis C: Hepatitis C passes through infected blood and children born to mothers who have the virus or who have a blood clotting problem, such as hemophilia or who need dialysis for kidney failure.

Hepatitis D: Hepatitis D only happens in people already infected with hepatitis B.

Hepatitis E: Hepatitis E form of hepatitis is like hepatitis A. It is spread through fecal-oral contact. Symptoms can happen a bit differently in each child. Some children do not have any symptoms.

Symptoms of Acute Hepatitis

Symptoms of acute hepatitis include as follows:

- Flu-like symptoms
- Yellowing of the skin or the whites of the eyes (jaundice)

- Fever
- Nausea or vomiting
- Loss of appetite
- Not feeling well
- Stomach pain or discomfort
- Diarrhoea
- Joint pain
- Sore muscles
- Itchy red hives on the skin
- Clay-colored stools
- Dark-colored urine

Diagnosis of Acute Hepatitis

Blood Testing

- Liver enzymes
- Liver function
- Antibody and polymerase chain reaction. This is to check for the type of hepatitis.
- Cellular blood counts
- Coagulation tests. These include international normalized ratio.

CT Scan: A CT scan shows detailed images of any part of the body. This test shows the child's bones, muscles, fat, and organs. CT scans are more detailed than general X-rays.

Ultrasound: Ultrasound uses sound waves to examine parts of the body. It is very effective in examining the liver.

MRI: MRI test uses large magnets, radio waves, and a computer. Together, these show detailed images of organs and structures inside your child's body.

Liver Biopsy: A tissue sample is taken from a child's liver and closely observed under a microscope.

How is Hepatitis Treated in a Child?

Treatment of hepatitis depends on the symptoms, age, and general health. It also depends on how severe the condition is.

The treatment depends on what's causing his or her hepatitis. The goal of treatment is to stop damage to the liver. It is also to help ease symptoms. The treatment may include:

- **Medicines:** These can control itching, treat the virus, or control an •autoimmune disease.

- **Supportive Care:** This includes eating a healthy diet and getting enough rest.
- **Reducing Risk:** Not using alcohol or illegal drugs.
- **Blood Testing:** With the help of blood testing the disease can be detected and seen it's progressing.
- **Hospital Stay:** Admission in hospitals is done in severe cases.
- **Liver Transplant:** Liver transplant is done for end-stage liver failure.
- **Helping to Prevent the Spread of Viral Hepatitis:** Having good personal health (hygiene) habits, such as handwashing.

Key Points about Hepatitis in Children

- Hepatitis is an inflammation of the liver. It can damage and destroy liver cells.
- Hepatitis in children can be caused by many things. Your child can get hepatitis by being exposed to a virus that causes it.
- There are 5 main types of the hepatitis virus: A, B, C, D, and E.
- The most common symptoms of hepatitis include a yellowish color to the skin and whites of the eyes (jaundice) and flu-like symptoms.
- Some children do not have any symptoms.
- Getting vaccinated and having good hygiene can prevent hepatitis.

Nutritional Considerations in Hepatitis of an Infant

In infants, these nutrition considerations apply to prevention and treatment of viral hepatitis:

- Lactation should be encouraged in infants below 6 months of age.
- Sterilization of all feeding utensils and bottles necessary.
- Easy to digest, soft, well-cooked carbohydrates, fruits, vegetables are encouraged in children recovering from hepatitis infection.

Hygiene and Sanitation: It is important for children eating complimentary foods to avoid uncooked fruits and vegetables. Boiling or cooking food and water for e" 1 minute to 85°C (185°F) is necessary to inactivate the hepatitis virus.

Avoiding High-Iron Foods and Iron Supplements: Along with phlebotomy, a low-iron diet will help reduce the risk for hepatocellular carcinoma in infants the Hants hepatitis C progression occurs as a result of accelerated hepatic iron uptake and the oxidative stress caused by iron-catalyzed free radical production.

Nutritional Supplementation May be Required: Treatment with Interferon (IFN) can cause digestive complaints with a subsequent reduction in appetite and food intake and has been reported to result in weight loss in 11-29% of treated patients.

A Low-Fat, Low-Cholesterol Diet is Helpful: Chronic hepatitis C infection increases the risk for hepatic steatosis. A higher intake of dietary cholesterol which aggravates the clinical problem and is associated with the progression of hepatitis C-related liver disease. Individuals need to be on a dietary regimen which is reduced in fat (23% of calories) and cholesterol (185 mg/d) for reduction in elevated liver enzymes.

Adequate Vitamin D Status: Vitamin D deficiency is common in patients with chronic liver disease, and these patients may have a reduced ability to convert vitamin D to its active form thus vitamin D supplementation improves the probability of response to treatment for hepatitis.

Avoidance of Extremes in B12 Status: B12 status helps with clearance of hepatitis C from the circulation of infected patients however, overly high serum B12 levels may also foster viral replication.

Viral hepatitis is probably a mild and self-limiting but it can become chronic, depending on the virus involved and the success of medical treatment provided.

Check Your Progress

1. On what is infant's mortality associated?
2. What is the main objective of nutrition therapy in infant with diarrhoea?
3. List some important points to keep in mind while preparing food for consistency, digestibility.
4. Should lactation needs to be encouraged in breast fed infants?
5. How is dietary management of infant with diarrhoea done?
6. What are the symptoms of typhoid?
7. List the ways in which typhoid can be treated.
8. What is hepatitis?
9. How is Hepatitis A and B virus spread?
10. Give some symptoms of acute hepatitis.

11.3 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. In infants, mortality is associated with acute diarrhoea primarily due to the clinical dehydration that results from the loss of excessive body water and electrolytes in the stool.
2. The main objective of nutrition therapy in infant with diarrhoea is to minimize the adverse effects of the chronic loose motions and infection on nutritional status of the infant.

3. Important points to keep in mind while preparing food consistency, digestibility are as follows:
   - Watery gruels or thin vegetable soups can be given but should not be much diluted and excessively bulky foods need to be avoided as primary nutrient sources if possible.
   - When formulated appropriately, watery gruels or soups can be used as adjuncts to fluid and electrolyte therapy, but never as a complete diet, because the concentrations of energy and nutrients in these preparations are usually too low.
   - Local food-processing techniques should be used whenever possible, because of their familiarity to the population. For example, the digestibility of legumes can be improved through familiar cooking, fermenting, or germinating techniques that are not ordinarily used for infant feeding; particle size can be reduced by using simple food mills.
4. Lactation needs to be encouraged in breast fed infants, even during rehydration, by alternating between oral rehydration solutions and breast milk.
5. Dietary management in the infant with diarrhoea can be done as follows:
   - Discontinuation of feeding is not encouraged.
   - Mandate feeding in children needs to be continued even during diarrhoea if their intake and weight gain are appropriate.
   - It is noted that continuum feeding in infants will improve absorptive capacity, as substrates needed for tissue repair are provided and the treatment of diarrhoea might require the introduction of simpler, more easily digested foods.
   - Importantly, serious diarrhoea requires fluid replacement with either oral rehydration solution or intravenous fluids and the diet should not be changed too often. Clinically takes 2–3 days for assessment and for natural diarrhoea process to abate and any complications of feeding to become apparent.
6. The symptoms of typhoid fever is seen from a mild illness with:
   - Low Grade Fever
   - Headache
   - Fatigue
   - Malaise
   - Loss of Appetite
7. Typhoid can be treated in the following way:
   - Antipyretics.
   - Adequate rest, hydration, correction of fluid-electrolyte imbalance.

- Adequate nutrition: a soft, easily digestible diet should be continued unless the patient has abdominal distension or ileus.
- In case of severe illness monitor blood pressure, blood sugar, electrolytes, hemoglobin, platelet counts and liver functions as indicated.
- The infection risk factors of TB are: poverty, overcrowding, food insecurity and Human Immunodeficiency Virus (HIV).

8. Hepatitis is an inflammation of the liver. It can damage and destroy liver cells. It is caused by being exposed to a virus that causes it.
9. Hepatitis A virus is passed through fecal-oral contact of contaminated food or water, whereas Hepatitis B is spread when blood from an infected person enters another person's body and infants may get from infected mother during pregnancy or during blood transfusions/dialysis or infected syringes.
10. Symptoms of acute hepatitis include as follows:
    - Flu-like symptoms
    - Yellowing of the skin or the whites of the eyes (jaundice)
    - Fever
    - Nausea or vomiting
    - Loss of appetite
    - Not feeling well
    - Stomach pain or discomfort
    - Diarrhoea
    - Joint pain

11.4 SUMMARY

- The requirements of growth and organ development create a challenge in nutritional management of newborn infants.
- The stress of critical illness further complicates the delivery of adequate nutrients.
- Enteral feeding has several advantages over Parenteral Nutrition (PN), such as preservation of the gastrointestinal mucosa and decreasing the occurrence of sepsis related to bacterial translocation.
- In infants, mortality is associated with acute diarrhoea primarily due to the clinical dehydration that results from the loss of excessive body water and electrolytes in the stool.
- To prevent dehydration in children willing and able to drink will be rehydrated orally with Oral Rehydration Therapy (ORT).

- After completing the rehydration, hydration needs to be maintained during continuing diarrhoea by alternating between the oral solution and water.
- Water can be provided by breast-feeding on demand or by giving plain water equal to about 50% of the volume of the oral solution administered, i.e., 2 parts of Oral Rehydration Therapy (ORT) solution to 1 part water or breast milk.
- At home, if Oral Rehydration Solution (ORS) formula is not there then it can be made with the ingredients present in the kitchen, i.e., salt and a source of glucose found in the kitchen.
- The source of glucose is usually the everyday refined household sugar or properly finely prepared rice powder as these appear to be better in facilitating the absorption of electrolytes and water.
- Infants below the age group of 6 months of age do not have a completely developed gut and lack of pancreatic amylase, due to this reason the infant cannot completely digest these starches.
- The small proportions of patients who have severe dehydration and shock, or who are unable to drink require immediate intravenous therapy.
- Persistent vomiting is often given as a reason for withholding ORT solutions, but vomiting usually stops in the first 4 hours if ORT solutions are judiciously used.
- The main objective of nutrition therapy in infant with diarrhoea is to minimize the adverse effects of the chronic loose motions and infection on nutritional status of the infant.
- As a pediatric nutritionist one needs to acknowledge that the choice of foods, medium of meal preparation, and frequency of feeding depends on the age of the child along with the feeding history, and physiologic status.
- Animal protein is more easily digestible and is of higher biologic quality than plant protein.
- Dietary fat should supply about 40–50% of dietary energy during the first 6 months of life and approximately 35–40% for the remainder of early childhood.
- Vegetable fats that include relatively high proportions of unsaturated fat or fats of medium chain length are recommended for the first 6 months of life and are preferred during the early phases of treatment for diarrhoea, because they are generally more digestible and absorbable than highly saturated, long-chain fats.
- The principal types of dietary carbohydrate are starches and the disaccharides sucrose and lactose.
- Lactation needs to be encouraged in breast fed infants, even during rehydration, by alternating between oral rehydration solutions and breast milk.

- In developing nation with high density of people living in close community in India, Despite the burden of both malnutrition and tuberculosis in children worldwide, there are few studies on the mechanisms that underlie this relationship. From available research, it appears that malnutrition is a predictor of tuberculosis disease and is associated with worse outcomes. This is supported through several lines of evidence, including the role of vitamin D receptor genotypes, malnutrition's effects on immune development, respiratory infections among malnourished children, and limited work specifically on pediatric tuberculosis and malnutrition. Nutritional supplementation has yet to suggest significant benefits on the course of tuberculosis in children. There is a critical need for research on childhood tuberculosis, specifically on how nutritional status affects the risk and progression of tuberculosis and whether nutritional supplementation improves clinical outcomes or prevents disease.tuberculosis remains a significant reason of illness amongst children in financial limited settings.
- The infection risk factors of TB are: poverty, overcrowding, food insecurity and Human Immunodeficiency Virus (HIV).
- World Health Organization (WHO, indicates that malnutrition is a significant risk factor for childhood tuberculosis but there are numerous challenges in diagnosing pediatric tuberculosis.
- Christine H. Yang *et al*, showed that the liver plays a crucial role in many of the body's metabolic processes, including regulating protein, fat, and carbohydrate metabolism; vitamin storage and activation; and detoxification and excretion of waste products.
- Hepatitis is an inflammation of the liver. It can damage and destroy liver cells.
- Hepatitis is caused by being exposed to a virus that causes it.
- **Enteroviruses** is a group of viruses often seen in children. They include coxsackieviruses and echoviruses.
- **Adenovirus** is a group of viruses that causes colds, tonsillitis, and ear infections in children. They can also cause diarrhoea.
- **Parvovirus** virus causes fifth disease. Symptoms include a slapped-cheek rash on the face.
- Hepatitis A virus is passed through fecal-oral contact of contaminated food or water.
- Hepatitis B is spread when blood from an infected person enters another person's body and infants may get from infected mother during pregnancy or during blood transfusions/dialysis or infected syringes.
- Hepatitis C passes through infected blood and children born to mothers who have the virus or who have a blood clotting problem, such as hemophilia or who need dialysis for kidney failure.

- Ultrasound uses sound waves to examine parts of the body. It is very effective in examining the liver.
- Treatment of hepatitis depends on the symptoms, age, and general health. It also depends on how severe the condition is.
- Treatment with Interferon (IFN) can cause digestive complaints with a subsequent reduction in appetite and food intake and has been reported to result in weight loss in 11-29% of treated patients.
- Vitamin D deficiency is common in patients with chronic liver disease, and these patients may have a reduced ability to convert vitamin D to its active form thus vitamin D supplementation improves the probability of response to treatment for hepatitis.

11.5 KEY WORDS

- **Diarrhoea**: Diarrhoea is the frequent passing of loose, watery and unformed faeces.
- **Lactation**: Lactation describes the secretion of milk from the mammary glands and the period of time that a mother lactates to feed her young.
- **Typhoid**: Typhoid is a bacterial infection that can lead to a high fever, diarrhea, and vomiting.
- **Tuberculosis**: Tuberculosis (TB) is a contagious infection that usually attacks your lungs. It can also spread to other parts of your body, like your brain and spine.
- **Hepatitis**: Hepatitis is an inflammation of the liver.

11.6 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What is the main objective of nutrition therapy?
2. What is the nutrition advice given in diarrhoea?
3. How is food prepared for infants having diarrhoea?
4. Write a short note on frequency and progression of feeding diarrhoea.
5. What is typhoid and how is it treated?
6. How is nutritional needs and support for children with chronic liver disease fulfilled?

7. Name the various viruses that causes hepatitis in children.
8. Give the symptoms of acute hepatitis.
9. How is Hepatitis Treated in a Child?

Long-Answer Questions

NOTES

1. Discuss about nutritional management of diarrhoea.
2. Explain the dietary management in the infant with diarrhoea.
3. Elaborate a note on nutritional management of typhoid.
4. Describe about the nutrition in child with tuberculosis disease.
5. Describe about Tuberculosis (TB) in infants, its diagnosis, causes, nutritional management and treatment.
6. Explain the nutritional management of hepatitis.

11.7 FURTHER READINGS

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BLOCK - IV
NUTRITIONAL MANAGEMENT FOR CHILDREN WITH SPECIAL CONDITIONS

NOTES

UNIT 12 MANAGEMENT OF FLUIDS AND ELECTROLYTES

Structure

12.0 Introduction
12.1 Objectives
10.2 Lactose Intolerance, Celiac Disease, Inflammatory Bowel Disease, Constipation and Fat Absorption Test Diet of Infants
12.2.1 Lactose Intolerance and Celiac Disease
12.2.2 Inflammatory Bowel Disease (IBD)
12.2.3 Constipation and Fat Absorption Test Diet of Infants
12.2.4 Calculation of Fluids and Electrolytes: Both Deficit and Maintenance and Management of Calorie Intake
12.3 Answers to Check Your Progress Questions
12.4 Summary
12.5 Key Words
12.6 Self Assessment Questions and Exercises
12.7 Further Readings

12.0 INTRODUCTION

Lactose intolerance is the inability to break down a type of natural sugar called lactose. Lactose is commonly found in dairy products, such as milk and yogurt. One become lactose intolerant when your small intestine stops making enough of the enzyme lactase to digest and break down the lactose. When this happens, the undigested lactose moves into the large intestine. The bacteria that are normally present in your large intestine interact with the undigested lactose and cause symptoms, such as bloating, gas and diarrhea. The condition may also be called lactase deficiency. Lactose intolerance usually causes gastrointestinal symptoms, such as gas, bloating, and diarrhea, about 30 minutes to two hours after ingesting milk or other dairy products containing lactose.

Celiac disease, sometimes called celiac sprue or gluten-sensitive enteropathy, is an immune reaction to eating gluten, a protein found in wheat, barley and rye. If

you have celiac disease, eating gluten triggers an immune response in your small intestine. Over time, this reaction damages your small intestine's lining and prevents it from absorbing some nutrients (malabsorption). The intestinal damage often causes diarrhea, fatigue, weight loss, bloating and anemia, and can lead to serious complications. In children, malabsorption can affect growth and development, besides causing the symptoms seen in adults. There is no cure for celiac disease but for most people, following a strict gluten-free diet can help manage symptoms and promote intestinal healing.

The term Inflammatory Bowel Disease (IBD) describes a group of disorders in which the intestines become inflamed. It has often been thought of as an autoimmune disease, but research suggests that the chronic inflammation may not be due to the immune system attacking the body itself. Instead, it is a result of the immune system attacking a harmless virus, bacteria, or food in the gut, causing inflammation that leads to bowel injury. Two major types of IBD are ulcerative colitis and Crohn's disease. Ulcerative colitis is limited to the colon or large intestine. Crohn's disease, on the other hand, can involve any part of the gastrointestinal tract from the mouth to the anus. Most commonly, though, it affects the last part of the small intestine or the colon or both.

Constipation in infants less than one year of age is common, but it can be a source of concern for parents. Sometimes the baby is not really constipated, but must be given time to set his own schedule for having a bowel movement. Normally, an infant's stool is soft and easily passed. Even if an infant is not constipated, his bowel movements may be irregular. In rare cases, constipation may be caused by a lack of nerves or by structural problems in the lower large intestine.

In this unit, you will study about lactose intolerance, celiac disease, inflammatory bowel disease, constipation and fat absorption test diet of infants, calculation of fluids and electrolytes-both deficit and maintenance and management of calorie intake.

12.1 OBJECTIVES

After going through this unit, you will be able to:

- Understand about lactose intolerance
- Discuss the celiac disease
- Explain about inflammatory bowel disease
- Describe constipation and fat absorption test diet of infants
- Analyse the calculation of fluids and electrolytes-both deficit and maintenance and management of calorie intake

10.2 LACTOSE INTOLERANCE, CELIAC DISEASE, INFLAMMATORY BOWEL DISEASE, CONSTIPATION AND FAT ABSORPTION TEST DIET OF INFANTS

Lactose intolerance, celiac disease, inflammatory bowel disease, constipation and fat absorption test diet of infants are the diseases that infants face when they are born. These are explained as follows:

12.2.1 Lactose Intolerance and Celiac Disease

Lactose intolerance is a digestive disorder caused by the inability to digest lactose, the main carbohydrate in dairy products. Lactose intolerance is the condition when infants complain of uncomfortable digestive symptoms of bloating, flatulence and diarrhea after consumption of feeds that contain lactose from dairy. Lactose is the carbohydrate which is naturally found in dairy products like milk and milk products cheese, curd and ice cream.

The indigestion due to lactose intolerance is due to the lactose mal absorption because the small intestines cannot digest the lactose present in milk and milk products which are primarily due to deficiency or absence of lactase enzyme.

Congenital alactasia is a genetic lactase deficiency disorder in which the infants gut is incapable or unable to break down the lactose in the breast milk or formula milk. Lactose intolerance causes severe diarrhea in infants, which is different from milk allergy, as milk allergy is an immune system disorder.

In infants the factors that require diagnosis of presence of lactose intolerance:

- Abdominal Pain
- Flatulence
- Diarrhea
- Colic Pain
- Stagnant Weight

While, we know that most infants are able to digest lactose but many people begin to develop lactose malabsorption, a reduced ability to digest lactose after infancy. In the case, of expected lactose intolerance, certain tests are conducted for babies where a stool test is conducted, and if it is acidic (the PH of the stool less than 5.5, with a presence of reducing substance above 5 per cent), then it can be determined that the infant has a possibility of lactose intolerance.

Treating Lactose Intolerance

While treating lactose intolerance investigators need to be verify the symptoms as an infant not gaining weight, recurrent diarrhoea, recurrent abdominal pain or vomiting are associated features of lactose intolerance. In case the stool test

suggestive of lactose intolerance the child's pediatrician consider definite lactose elimination from the diet. Lactose-free formulas can be recommended by doctors for infant's gut health. There is speculation on the need or continuation of breastfeeding since breast milk also contains lactose. Some doctors recommend that breastfeeding should be continued unless the child is highly symptomatic. Few doctors may suggest that it is better to abstain from breast milk for a while to see if the symptoms improve. There may be a trial period where lactose is eliminated altogether from the feed and once the baby's weight and symptoms are evaluated, suitable measures can be adopted:

- Primary lactose intolerance requires a lactose-free diet that needs to be continued for a prolonged period of time.
- Secondary lactose intolerance following an episode of diarrhoea or dysentery is a transient phase and milk-based feeds can be stopped during this span. Usually, children recover from secondary lactose intolerance and, after a while, they can start digesting lactose.

However, if similar symptoms persist then the child has to undergo a medical retest and to decide if a lactose-free diet has to be continued for a longer period. There is no restriction with other diets barring lactose. After a lactose-free diet, it has been observed that such babies start gaining weight and symptoms improve to a large extent.

Lactose intolerance in the infant can occur anytime and not just during the weaning period. If a child has primary and congenital lactose intolerance, then he will be symptomatic from birth itself. For a child with symptoms of recurrent pain, diarrhoea, flatulence or colic, the stool needs to be tested, which can be at six months, one year or any time after an attack of diarrhea to detect evidence of lactose intolerance. If a child has been weaned, lactose can be eliminated easily as by then, solid diet has been usually introduced. If the child is diagnosed with lactose intolerance when he is predominantly milk fed, then a lactose-free formula needs to be introduced.

Celiac Disease

Celiac disease is a digestive disorder caused by an abnormal immune reaction to gluten. Celiac disease is also known as:

- Sprue
- Non-tropical Sprue
- Gluten-Sensitive Enteropathy

Gluten is a protein found in foods made with wheat, barley, rye, and triticale. It is also found in oats that have been made in processing plants that handle other grains. Gluten can even be found in some medicines, vitamins, and lipsticks. Gluten intolerance, also known as gluten sensitivity, is characterized by the body's inability to digest or break down gluten. Some people with gluten intolerance have a mild

NOTES

sensitivity to gluten, while others have celiac disease which is an autoimmune disorder.

In Celiac disease, the immune response to gluten creates toxins that destroy the villi. Villi are tiny finger-like protrusions inside the small intestines. When the villi become damaged, the body is unable to absorb nutrients from food. This can lead to malnutrition and other serious health complications, including permanent intestinal damage.

According to the article published by Department of Pediatrics, Maulana Azad Medical College and Lok Nayak Hospital, Delhi in Indian Pediatr. 2009 May; 46(5):415-7. Epub 2009 Jan 21. PMID: 19213985. Celiac disease is increasingly observed in the wheat-eating population of north India. Although, its exact prevalence of in children is unknown as population screening studies are scarce.

However, the exact prevalence of Celiac Disease in children is not known as population screening studies are scarce. The study aimed to determine the prevalence of celiac disease in 400 children, 6 months to 12 years of age attending pediatrics department of a tertiary care hospital in North India. The screening diagnostic tool used for celiac disease determination was anti-tissue TransGlutaminase (tTG) antibodies and endoscopic duodenal biopsy was done in the anti–tTG positive subjects. Four patients were diagnosed with Celiac Disease as per the modified European Society for Paediatric Gastroenterology Hepatology and Nutrition (ESPGHAN) criteria. The prevalence of CD thus, was 1%, which was in concordance with screening studies using serological markers conducted in the West.

In India, gluten in diet is introduced between the age 4 and 6 months in infants, as per recommendations of exclusive breast feeding till age of 6 months and initiating weaning with gluten free foods. In infants there is a marked risk of developing food allergies, there is clear evidence that introducing solid foods before the end of the 3rd month is detrimental and should be avoided.

A recent trend supports the scientific notion that solid diet with gluten-containing foods should be introduced beyond the 6th month of life.

Another important aspect of gluten introduction into the diet has to do with its possible role in causing type-1 diabetes, i.e., Insulin-dependent diabetes mellitus (IDDM). Recently, a large epidemiological investigation in a cohort of children at risk for IDDM found that exposure to cereals (rice, wheat, oats, barley, rye) that occurred early (< or = 3 months) as well as late (> or = 7 months) resulted in a significantly higher risk of the appearance of islet cell auto-immunity compared to the introduction between 4 and 6 months. As for celiac disease, the protective role of breastfeeding can be considered ascertained, especially the protection offered by having gluten introduced while breastfeeding is continued. Evidence is emerging that early (< or = 3 months) and perhaps even late (7 months or after) first exposure to gluten may favour the onset of celiac disease in predisposed individuals.

NOTES

Additionally, large amounts of gluten at weaning are associated with an increased risk of developing celiac disease, as documented in studies from Scandinavian countries.

Supportive science proves indicates that:

- Breastfeeding at the time of gluten introduction will benefit by delayed appearance of celiac disease which reduces predominant gastrointestinal presentation of celiac disease.
- Based on current evidence, it appears reasonable to recommend that gluten be introduced in small amounts in the diet between 4 and 6 months, while the infant is breastfed, and that breastfeeding is continued for at least a further 2-3 months.

Diet for a Child with Celiac Disease

The treatment for celiac disease needs to be nutritionally balanced for age and requires the elimination of gluten which is a protein found in wheat, rye and barley from the diet.

12.2.2 Inflammatory Bowel Disease (IBD)

Inflammatory Bowel Disease (IBD) is chronic, idiopathic considered a debilitating disorder of the gastrointestinal tract. It may occur during childhood or adolescence in up to 25% of cases and a small percentage of children may present with irritable bowel disease in infancy. Therefore, there is a need for a thorough clinical evaluation in this age group as other conditions may mimic inflammatory bowel disease.

The clinical presentation of irritable bowel disease in infants includes symptoms of chronic diarrhea leading to failure to thrive with hematochezia, perianal disease, oral ulcerations, and small bowel obstruction.

There are two kinds of Irritable Bowels Disease:

- Crohn's Disease
- Ulcerative Colitis

Crohn's Disease: Medical definition, the layers of the intestinal wall become sore, inflamed, and swollen that can affect any part of the digestive tract, including the mouth, esophagus, stomach, small intestines, large intestines as well as the anus.

Ulcerative Colitis: Medical definition, inflammation in only the inner lining of all or part of the colon and rectum and sometimes, only the rectum is affected.

Irritable Bowel Disease is probably due to interaction of three essential factors:

- Genetic susceptibility
- Environment – local environment, gut micro flora, nutrition environment
- Immune response of the infant

NOTES

Infants feeding habits of excessive consumption of cow's milk, the consumption of high quantities of refined sugar and fat and the low consumption of dietary fiber, fruit and vegetables are risk factors to irritable bowels disease. The consumption of cow's milk needs to be implicated in the etiology of irritable bowel disease, and these patients show higher levels of serum antibodies against cow's milk protein compared to healthy controls.

The relationship between breastfeeding and irritable bowels disease has not been observed but various assumptions provide explanations as to the protective mechanisms of breastfeeding against gastrointestinal infections as well as ability of breast milk to stimulate the development of the gastrointestinal mucosa and its immunological capacity in children is encouraged in order to postpone drinking cow's milk and other allergens and potentially infectious agents.

Nutrition therapy plays a fundamental role in the clinical management of pediatric care for children with irritable bowel disease. The main objective of nutrition therapy is to correct macro and micronutrient deficiencies in malnourished infants due to increased oxidative catabolism and to reverse the physiopathological consequences of nutrition deficiencies as well as to exert anti-inflammatory therapeutic effect.

The enteral feeding using formulas or liquid beverages should ideally take preference over parenteral feeding, unless it has been completely contraindicated by the medical team.

The precise mechanism of action through which enteral nutrition operates in irritable bowel disease is not well known, but it has been suggested that it could act by modulating the immune system's mucosa, regulating imbalances in the bacterial flora capable of precipitating inflammation or by modifying the luminal content, thereby altering the expression of certain genes in the epithelium with an effect on the immune system of the mucosa, as well as reducing the exposure of the intestine to antigens.

In recent years, we have increased our knowledge of the immunoregulatory function of intestinal microflora and its possible participation in the physiopathology of irritable bowel disease.

Alteration of the composition and function of intestinal microbiota could lead to increased stimulation of the intestinal immune system, epithelial dysfunction and greater permeability of the mucosa, and accordingly, the correct characterization of the components of these microflora and the definition of their functions are vital in order to consider probiotic treatment for irritable bowel disease. Probiotics have shown to be as effective as mesalazine in preventing relapses in patients with ulcerative colitis and in the treatment of pouchitis. Efforts have also been made to identify dietary components (prebiotics) which are capable of regulating the bacterial composition, or which have a trophic effect on the intestinal epithelium.

Short-Chain Fatty Acids (SCFAs) (butyrate, propionate and lactate) result from the fermentation of fiber by bacterial species in the colon (*Bifidobacterium*,

Eubacterium and *Lactobacillus*), and are an important metabolic substrate for colonocytes that promote the good functioning of the mucosa. The anti-inflammatory effect of butyrate has been the most studied at different levels in the physiopathology of the inflammation, and it has been successfully tested as a treatment for patients with ulcerative colitis.

Parenteral nutrition is of scant therapeutic interest in irritable bowel disease since diverse studies have shown that intestinal rest is not beneficial to control the disease. Consequently, parenteral nutrition is not useful for the induction or maintenance of remission in Crohn's disease, nor do we have any evidence to support its use in ulcerative colitis. It is also very expensive and poses an additional risk due to the use of venous catheters. Its utility is therefore, restricted to certain cases involving efforts to close enterocutaneous or other complicated fistulas in patients with fistulizing, the treatment of short bowel syndrome following extensive resections for Crohn's disease, or when enteral feeding is impractical for other reasons.

Irritable bowel disease is an important risk for malnutrition in infants and nutritional support using liquid formulas should be considered especially for children and for those who may require prolonged cycles of corticosteroids. Enteral nutrition may be considered both as a primary treatment and as a supplement to other medication.

A rich and varied diet should be recommended for all patients with irritable bowel disease during remission, which includes fruit and vegetables, egg white, whey protein. We do not have any studies that support the restriction of fiber in the diet during flares of the disease but the consumption thereof could be temporarily restricted at this time. Because of their calcium content, dairy products are especially recommended for these patients and milk should only be restricted in the case of lactose intolerance, substituted by other fermented products (yoghurts and cheese) or calcium-enriched soya-based products. Calcium and vitamin D3 supplements are also required during treatments with systemic steroids and with those with a greater local effect, such as budesonide or becomethasone. Iron and folic acid deficiencies should be routinely monitored in patients with irritable bowel disease.

Deficiency in one or both micronutrients is the main cause of anemia in these patients and can be easily corrected. It is to be noted that ferritin is an acute phase reactant that increases during inflammation, which restricts its value as a marker of ferropenia in irritable bowel disease.

Treatment of iron deficiency in irritable bowel disease includes giving iron either orally or intravenously administered; the latter is recommended in cases of active inflammation in Crohn's disease, since oral supplementation might be of limited efficacy. The absorption deficiency of vitamin B12 contributes to anemia and hypercoagulability. The resection or involvement of the terminal ileum in Crohn's disease requires vitamin B12 supplementation *via* the parental route.

Ileum actively participates in enterohepatic circulation, which refers to circulation of bile acids from the liver where they are produced, to the small intestine, where they aid in digestion of fats and other substances, back to the liver. In this way, the distal ileum is necessary for fat and fat soluble vitamin absorption.

Crohn's disease patients frequently undergo resection of the terminal ileum, and if a large segment of bowel is removed malabsorption of these lipid diet components may appear.

In contrast to most conventional forms of drug therapy that suppress or modify the host immune response, probiotic therapy is aimed at one of the other contributors to disease pathogenesis the gut microflora. Probiotics are live microorganisms that confer a health benefit by altering the indigenous microflora. Probiotics may alter the gut microflora by competitive interactions with indigenous bacteria, production of antimicrobial metabolites, or modulation of the local immune response to enteric bacteria.

In children, a study of probiotics with oral bacteriotherapy containing human *Lactobacillus casei* strain GG (given to 14 children with Crohn's disease) resulted in an increase in the gut IgA immune response. A study of *Lactobacillus GG*, given for 6 months to four children with mildly to moderately active Crohn's disease showed clinical improvement and concomitant decrease in intestinal permeability.

In complying with nutritional treatment, infant care should include tolerability to the food, its potential adverse effects, such as diarrhea or nausea and motivation of the mother and family who attend to the infant is influential. Attention should be paid to the distribution of the doses during the day and to the simultaneous administration of other solid food.

Feeding using the nasogastric tube may also be considered for patients with specific protein or energy intake requirements, which for different reasons, cannot be satisfied by oral intake, but they may be fed a nutritional supplement *via*, tube during the night.

Enteral nutrition is considered the number one treatment for irritable bowel disease in children, as an alternative to immunomodulatory drugs, due to its excellent safety record and advantages concerning growth. In these cases, cooperation between the patient's family and the professionals who care for him or her are particularly important to guarantee correct nutritional support.

Elemental/Polymeric Diets

Elemental diets\liquid feeds are considered to work by reducing mucosal antigen exposure, partly due to the nature of the feed and partly to faster transit times. They also alter the fecal flora, which causes local immunomodulation downscaling, which enhances nutritional status and allows relative bowel rest.

Compliance may be poor as elemental diets are not known for their palatability and are often delivered *via*, nasogastric tube, whereas the polymeric drinks are far more palatable.

Elemental diets offer a cheaper way of bringing about remission and without the side effect profile of Total Parenteral Nutrition (TPN).

However, enteral therapy for Crohn's disease has its role in selected cases, in particular, in children in whom steroids may cause growth retardation. Food exclusion with liquid diet is very difficult to maintain, therefore, these are rarely long-term solutions. Unfortunately, a staged return to normal feeding often leads to relapse and requires nutrition counseling.

Enteral *vs* Parenteral Feeding

There has been controversy regarding the enteral *vs* parenteral route for feeding in patients with irritable bowel disease. Comparison of Total Parenteral Nutrition (TPN) against elemental diet in a group of 36 patients showed no significant difference in the number of days to remission, the drop in Crohn's Disease Activity Index (CDAI) score, the Erythrocyte Sedimentation Rate (ESR), or albumin. However, in other studies that have agreed with this finding, neither was proven to be as beneficial as corticosteroids, except one study in a pediatric population. In that study, Sanderson, *et al.* entered 17 children into an RCT, in which eight were given an elemental diet for 6 week *via* a nasogastric tube, and seven were given adrenocorticotrophic hormone injections and oral prednisolone and sulfasalazine. The elemental diet was equally effective at improving the Lloyd-Still disease activity index scores, C-Reactive Protein (CRP), ESR and albumin. The elemental diet was markedly better at maintaining linear growth. Whilst strong evidence exists supporting the primary use of enteral feeding in children with Crohn's disease is not commonplace in the treatment of adults.

Omega-3 Fatty Acids

Omega-3 fatty acids derived from fish oils have been shown to be of benefit in a double-blind Randomized Controlled Trial (RCT) that looked at patients with distal ulcerative colitis. The study found that the group treated with 3.2 g Eicosapentaenoic Acid (EPA) or 2.4 g docosahexaenoic acid daily had significantly better clinical and sigmoidoscopic scores compared with the control group who took sunflower oil, after 3 and 6 months. This supports the concept that omega-3 oils suppress natural cytotoxicity.

Fiber

Dietary fiber has been investigated as a means of increasing Short-Chain Fatty Acid (SCFA) production. Irritable bowel disease has been linked with impaired SCFA production. SCFAs are mainly produced by the anaerobic bacterial fermentation of undigested carbohydrates and fiber polysaccharides. In 1995, Galvez, *et al.* reviewed a number of studies that concluded that dietary fiber confers clinical benefits in patients with Inflammatory Bowel Disease (IBD) because it maintains remission and reduces colonic damage. This is thought to occur by increasing SCFA production and by altering the gut flora towards predominantly non-pathogenic bacteria.

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Sugars

A high intake of sugar has been shown linked to Crohn's disease in a number of trials, hence its possible etiological role has led to therapeutic trials of sugar avoidance.

12.2.3 Constipation and Fat Absorption Test Diet of Infants

The prevalence of functional constipation is a common problem in children is 3% globally and in 17% to 40% of children, constipation starts in the first year of life. Constipation can be associated with infrequent or probably painful defecation, fecal incontinence, and abdominal pain that cause significant distress to the child and family and has a significant impact on health care cost.

Pediatric constipation may have several etiologies, in most children presenting with this symptom no underlying medical disease responsible for the symptom can be found.

Functional constipation is commonly observed in children trying to withhold feces who want to avoid painful defecation. Frequently, children with constipation also experience recurrent episodes of fecal incontinence due to overflow caused by fecal impaction known as encopresis.

Rome III diagnostic criteria for functional constipation (criteria fulfilled at least once per week for at least two months before diagnosis) as follows:

Must include two or more of the following in a child with a developmental age of at least four years, with insufficient criteria for the diagnosis of irritable bowel syndrome:

- Two or fewer defecations in the toilet per week.
- At least one episode of fecal incontinence per week.
- History of retentive posturing or excessive volitional stool retention.
- History of painful or hard bowel movements.
- Presence of a large fecal mass in the rectum.
- History of large diameter stools that may obstruct the toilet.

To treat constipation in infants is to produce soft, painless stools and to prevent the re-accumulation of feces. This can be achieved through a combination of education of parents, behavioral modification, daily maintenance stool softeners and dietary modification. Fecal dissipation may be necessary at the outset of treatment.

Table 12.1 Medications for the Treatment of Pediatric Constipation

Laxative	Dosage	Side Effects
Lactulose	1 mL/kg/day – 3 mL/kg/day in divided doses	Flatulence, abdominal cramps
Milk of Magnesia (Magnesium Hydroxide)	1 mL/kg/day – 3 mL/kg/day of 400 mg/5 mL available as liquid	Magnesium poisoning (infants). In overdose, hypermagnesemia, hypophosphatemia and secondary hypocalcemia
Polyethylene Glycol 3350	Disimpaction: 1 g/kg/day – 1.5 g/kg/day for 3 days Maintenance: Starting dose at 0.4 g/kg/day – 1 g/kg/day	Limited Occasional abdominal pain Bloating Loose stools
Polyethylene Glycol-Electrolyte Solution (Lavage)	Disimpaction: 25 mL/kg/h (to 1000 mL/h) by nasogastric tube until clear effluent Maintenance: 5 mL/kg/day – 10 mL/kg/day (older children)	Nausea Bloating Abdominal cramps Vomiting Anal irritation
Mineral Oil	Disimpaction: 15 mL/year – 30 mL/year of age (up to 240 mL daily) Maintenance: 1 mL/kg/day – 3 mL/kg/day <1 year of age: Not recommended	Lipid pneumonia if aspirated. Theoretical interference with absorption of fat-soluble substances, but no evidence
Senna	2–6 years: 2.5 mL/day – 7.5 mL/day 6–12 years: 5 mL/day – 15 mL/day	Idiosyncratic hepatitis Melanosis coli Hypertrophic osteoarthropathy Analgesic nephropathy
Bisacodyl	Oral: 3–12 years: 5 mg – 20 mg Rectal: <2 years: 5 mg/day 2–11 years: 5 mg/day – 10 mg/day	Abdominal cramping Nausea, diarrhea Proctitis (rare)
Docusate Sodium	5 mg/kg/day divided three times a day or as a single dose	Abdominal pain Cramping Diarrhoea
Glycerin Suppositories	–	None
Phosphate Enemas	<2 years old: Not recommended >2 years: 6 mL/kg (up to 135 mL)	Risk of mechanical trauma to rectal wall Abdominal distention or vomiting Hyperphosphatemia Hypocalcemia

NOTES

Behavioural Modification

A healthy toilet regimen with dedicated time for defecation is valuable learning for infant. A child needs to be taught a routine scheduled toilet sitting for 3 min to 10 min at least, once or twice a day with a footstool to support their legs effectively so as to increase intra-abdominal pressure. Parents should avoid punishment for not clearing bowels during the toileting time and praise for the behaviour of toilet sitting can be offered.

Dietary Modification

A balanced diet that includes whole grains, fruits and vegetables is recommended as part of the treatment of constipation in children. Carbohydrates (especially sorbitol) found in prune, pear and apple juices can cause increased frequency and water content in stools.

Although excessive milk intake can exacerbate constipation, there is insufficient evidence that eliminating it from the diet improves refractory constipation. For children unresponsive to adequate medical and behavioural management, consideration could be given to a time-limited trial of a cow's milk-free diet. Intolerance to cow's milk, particularly in children with atopy, has been associated with chronic constipation.

In infancy, constipation is mostly functional, but a heightened vigilance for identifying red flags suggestive of an organic disorder in this age group is necessary. It is known that breastfed infants can have greater variability than formula-fed infants in stool frequency. Some normal breastfed newborns may stool with each feeding or may not have a bowel movement any more often than every seven to 10 days. Mineral oil is contraindicated in infants because of uncoordinated swallowing and the risk of aspiration and subsequent pneumonitis. Increased intake of fluids and reducing excess cow's milk intake may be helpful for constipation in older infants. Recommendations to add brown sugar to formula or water for infant constipation are anecdotal and not evidence based, as well as pose a risk of caries development. Lactulose and glycerin suppositories may be used.

Consultation with a gastroenterologist should be sought when adequate therapeutic measures fail or there is a concern that the disease still exists.

Fat Absorption Test Diet of Infants

Development of the Gut in Infants: Birth of the infant foresees a dramatic transition in the supply of nutrients from the placenta to the gut thereby with the first feeding exposes the gastrointestinal system to a new ingredient variant from the amniotic fluid. This transition generates the necessity to digest macronutrients prior to their absorption and makes the gut, with its large, folded surface, our biggest interface to the outside world.

The complex development of digestive functions in human newborns is under studied as the clinical investigation of digestive processes requires invasive procedures inclusive nasogastric and nasoduodenal tubes or the drawing of blood samples limiting possibility in the healthy term infants.

Nutrition in the preterm infants is via, a gastric tube that also allows the collection of samples; lipid digestion has only been functionally investigated in preterm infants but not term infants.

Lipids

Lipids are a broad group of small molecules of fat inclusive of Triacylglycerols (TAGs), hydrophobic or amphiphilic compounds, such as Phospholipids (PLs), Monoacylglycerols and Diacylglycerols (MAGs and DAGs) as well as sterols. Investigating from the stool samples of infants it is seen that lipids are not completely absorbed by infant's gut.

The amount of fat that is excreted with the stool can approximate 10 % in full term infants and 10–30 % in preterm infants. The amount of unabsorbed fat appears to depend essentially on gestational and postnatal age and the type of fat correlates with the maturation of the digestive system, be it the digestive function, i.e., enzyme and bile salt levels), absorptive capacity, or a combination of both.

Infant Lipid Digestion and Microbiota Composition

Unabsorbed lipids are transported to the colon where they get utilized by the colonic microbiota. The latter has been extensively credited for its relevance in health and disease. It provides nutrients and energy through the fermentation of dietary and endogenous components. During the first year of life, the dietary influence on the development of microbiota composition and functionality has been extensively studied. As such, human milk oligosaccharides have been identified to be critical for shaping the gut's microbiota composition.

Pediatrician may suggest fecal fat test for infants incase the child is undernourished and not feeding or has chronic diarrhea. The test will help investigate underlying concerns of loose motions, vomiting, jaundice, apathy and malnourishment in infant due to:

- Celiac disease due to intolerance to gluten.
- Crohn's disease an inflammation of digestive tract.
- Cystic fibrosis in the digestive tract.
- Pancreatitis an inflammation of the pancreas.
- Cancer in pancreas or biliary tract.

All these concerns will affect the absorption of fat due to inefficiency of bile production in the gallbladder or liver, production of digestive enzymes in the pancreas, normal functioning of the intestines.

What is Fecal Fat Test?

It measures the amount of fat in the stool which can help measure the percentage of dietary fat that the body does not absorb.

Sample is collected in infants:

- The stool is collected on a plastic wrap that is loosely placed over the toilet bowl and held in place by the toilet seat. Then put the sample in a clean container.

- For infants and children wearing diapers, you can line the diaper with plastic wrap. If the plastic wrap is placed properly, you can prevent mixing of urine

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Fat malabsorption can cause a change in the stools which is called steatorrhea. To absorb fat normally, the body needs bile from the gallbladder (or liver if the gallbladder has been removed), enzymes from the pancreas, and a normal small intestine. Normal Results: Less than 7 g of fat per 24 hours.

12.2.4 Calculation of Fluids and Electrolytes: Both Deficit and Maintenance and Management of Calorie Intake

Fluid and Electrolyte Management in Newborn

For wellbeing of a newborn probably unwell or born preterm the careful fluid and electrolyte management is essential for as inadequate administration of fluids can result in hypovolemia, hypersomolarity, metabolic abnormalities and renal failure.

Note that in full term neonate's or preterm baby's excess fluid administration results in generalized edema and abnormalities of pulmonary function. Excess fluid administration in the very low birth weight infant is associated with patent ductus arteriosis and congestive heart failure, intraventricular hemorrhage, necrotizing enterocolitis and bronchopulmonary dysplasia.

The management of fluid and electrolyte therapy in term and preterm neonates requires rational understanding of several physiologic principles.

Physiology

- Body Composition and Surface Area
  - The body composition of the fetus changes during gestation with a smaller proportion of body weight composed of water as gestation progresses.
  - The preterm fetus or neonate is in a state of relative total body water and extracellular fluid excess. After birth this excess water must be mobilized and excreted.
  - A proportion of the diuresis observed in both term and preterm infants during the first days of life should be regarded as physiologic.
  - The surface area of the newborn is relatively large and increases with decreasing size. Therefore, insensible water losses will be greatest with small size and decreased gestational age.
- Hormonal Effects
  - The Renin-angiotensin system is very active in the first week of neonatal life resulting in increased vascular tone and elevated levels of aldosterone
  - Increased aldosterone levels enhance distal tubular reabsorption of sodium resulting in an impaired ability to excrete a large, or acute, sodium load.

NOTES

- o Arginine Vasopressin (AVP) and Antidiuretic Hormone (ADH) levels rise after birth. AVP secretion is increased in response to stress, such as birth, asphyxia, Respiratory Distress Syndrome (RDS), positive pressure ventilation, pneumothorax and intracranial hemorrhage.
- Renal Hemodynamics: After birth, renal blood flow increases in response to increased blood pressure (renin-angiotensin) with a secondary increase in glomerular filtration rate. However, the neonatal kidney is less efficient at excreting an acute sodium or water load than the kidney of an infant or child.
- Sodium Homeostasis
  - o Sodium is required for fetal growth with an accretion rate of 1.2 mEq/kg/day between 31-38 weeks.
  - o Sodium retention is aided by increased aldosterone levels in newborns.
  - o In preterm infants <34 weeks sodium reabsorption is decreased, the fractional excretion of Na may exceed 5%. However, the preterm infant is unable to rapidly increase sodium excretion in response to high sodium levels or a large sodium load.
- Water Handling: Both term and preterm infants are able to excrete dilute urine. Conversely, preterm infants are able to concentrate urine to ~ 600 mOsm/L and the term infant to ~ 700 mOsm/L. (Adults can concentrate to ~ 1300 mOsm/L). Therefore, both preterm and term neonates generally have the capacity to regulate their intravascular volume within a range of fluid intakes.

Based on the Above Principles

- One should expect a 10-15% weight loss over the first 5-7 days of life (up to 20% in infants <750 g).
- Infants which experience significant intrapartum stress will be slow to void and will therefore, require less fluid over the first 24-48 hours.
- The small or extremely immature infant <1000 g will experience increased Insensible Water Losses (IWL). IWL = (I-O) - (± Δwt).
- As the preterm and term infant is able to regulate urine output in response to hypovolemia, urine output will reflect intravascular volume. In other words, the infant will generally not maintain inappropriately high urine output in the face of intravascular volume depletion.

Recommendations

- Initiate fluid therapy at 60-80 ml/kg/d with D10W, (80-150 ml/kg/d for infants d" 26 weeks).

- Infants <1500 g should be covered with a saran blanket and strict I&O should be followed. For infants < 26 weeks the saran blanket should be applied directly upon the infant to minimize Insensible Water Losses (IWL).
- Infants <1000 g should have electrolytes and weights recorded every 6-8 hours; every 12 hours for infants 1000-1500 grams.
- For serum Na+ >145 mEq/L, increase infusate by ~10 mL/kg/d without Na+ in the infusate.
- Increase fluids for urine output <0.5 mL/kg/hr by ~10 mL/kg or, in infant d” 26 weeks, calculate Insensible Water Losses (IWL) and change fluids accordingly.
- Infuse Na+ free fluids (including flushes) until serum Na+ <145 and good urine output is established (post diuretic phase). Then add 3-5 meq/kg/d Na+.
- Add KCl (2-3 meq/kg/d) to IV fluids after urine output is well established and K+ <5 mEq/L (usually 48-72 hours).
- Increase fluid administration gradually over the first week of life to 120-130 cc/kg/d by day 7, allowing for expected physiologic weight loss.

Special Cases

While the above guidelines are more directed toward the LBW infant, especially <1000 g, they are generally applicable to most neonates; however, there are instances where these guidelines should be modified. Some of the more common modifications are noted below:

Postoperative Abdominal Surgery

Fluid requirements may be twice or three times that noted above. The more extensive the procedure the greater the needs. These infants may require 125-150 ml/kg/day immediately postoperative with subsequent increases as determined by blood pressure measurements and urine output. Isotonic saline also may be required because of third spacing of fluid into tissues and other spaces, for example the bowel lumen. Strict Intake (I) and Output (O) is mandated. Gastric drainage is replaced q8-12h, depending on volume, with isotonic saline. Colloid also may be needed because of rapid fluid shifts, decreases in arterial pressure, and increases in capillary filling time (i.e., > 3 sec.).

Asphyxiated Infants

Asphyxiated infants may have increased secretion of arginine vasopressin (which is likened to Syndrome of Inappropriate Antidiuretic Hormone Secretion (SIADH) and are thought to be at increased risk for cerebral edema. Their fluid intake should be kept on the low side for 48-72 hours, i.e., d” 60 ml/kg/day, or until seizures are no longer considered a problem. These infants require close monitoring of serum sodium and weight. Treatment of SIADH is by restriction of fluids, not increased sodium intake.

Infants of Diabetic Mothers

Infants of diabetic mothers receive intravenous glucose because of increased danger of hypoglycemia; however, they frequently do not receive sodium and have been found to develop rather substantial hyponatremia at 24 hours if this is not added at or before this time. This danger is greater the greater rate of glucose needed to maintain blood glucose. Addition of sodium should be considered at 16-18 hours.

Fluid therapy for the neonate can be rationally planned if several physiologic concepts are kept in mind. Firstly, the neonate has an excess of total body water at birth, particularly extracellular water, which must be redistributed and excreted. The renin-angiotensin system is in high gear during the first week after birth; thus not only is Plasma Angiotensin II (Ang II) likely to be elevated, but also aldosterone, which is a mineralocorticoid and has the potential to modulate sodium excretion/ reabsorption. The surface of the newborn is large and increases with decreasing size; therefore there is a greater probability of excess Insensible Water Loss (IWL), which may be exaggerated as birth weight and gestational age decrease and open radiant warmers rather than incubators are used. Finally, in most instances the neonatal kidney has the capacity to not only dilute urine, but also to concentrate it, reaching values of 600-700 m0sm/L (specific gravity d" 1.015). It should be noted, however, that this is less than that seen in adults or term infants. These observations are contrary to previous beliefs, and each of these aspects of the neonate are reviewed elsewhere (J Pediatr 101:387, 1982).

Our goal in the Low Birth Weight (LBW) infant d"1599 g is to allow a gradual weight loss over the first week, i.e., 5-6% over the first 24 hour and 12-15% by the end of the first week. We also attempt to maintain urine output e" 0.5 ml/kg hour. If IWL plus urine output significantly exceeds intake, weight loss may be greater than desired and occur more rapidly in the preterm LBW infant. This in turn may result in development of hypernatremia since fluid losses through the skin are essentially free water. To take each of these into account, the first approach to fluid therapy is adequate monitoring and appropriate supportive care. Thus, all infants d"1000 g birth weight should be maintained on a bed scale, kept on strict input and output measurements, and covered with a saran blanket to minimize IWL, especially if cared for in an open radiant warmer.

It is estimated that the non-growing neonate requires 60-75 kcal/kg/day and that fluid losses are closely related to caloric expenditure. Thus, in the first 1-3 days after birth fluid requirements are likely to be in the range of 65-75 ml/kg/ day in a neutral thermal environment. To accomplish this we use 10% Dextrose in Water (D10W). Therefore, at 24 h the fluid should be changed to D10 with 1/4 isotonic saline. The addition of Potassium Chloride (KCl) to the infusate should be considered by day 3 if there are no contraindications, for example poor renal function or hemolytic disease, at 2-3 mEq/kg/day. Although negative potassium balance occurs with this approach it is quickly corrected.

Our approach to fluid therapy has been to gradually increase the volume to approximately 75-80 ml/kg/day on day 2, 90-95 ml/kg/day on day 3, and -125 ml/kg/day by day 7. At 14 days most infants are receiving about 135 ml/kg/day.

NOTES

Check Your Progress

1. What is lactose intolerance?
2. Give the reason for indigestion due to lactose intolerance.
3. List the factors that require diagnosis of presence of lactose intolerance in infants.
4. What is celiac disease?
5. What is gluten?
6. Define villi. What happens when they get damaged?
7. How is celiac disease treated?
8. What is IBD?
9. Name two types of IBD.
10. How is IBD caused?
11. What is constipation in children?
12. How can problem of constipation can be avoided by the parents?
13. How is constipation treated in children?
14. Where does unabsorbed lipids go?

12.3 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Lactose intolerance is a digestive disorder caused by the inability to digest lactose, the main carbohydrate in dairy products. Lactose intolerance is the condition when infants complain of uncomfortable digestive symptoms of bloating, flatulence and diarrhea after consumption of feeds that contain lactose from dairy. Lactose is the carbohydrate which is naturally found in dairy products like milk and milk products cheese, curd and ice cream.
2. The indigestion due to lactose intolerance is due to the lactose mal absorption because the small intestines cannot digest the lactose present in milk and milk products which are primarily due to deficiency or absence of lactase enzyme.
3. In infants the factors that require diagnosis of presence of lactose intolerance:
   - Abdominal Pain
   - Flatulence

- Diarrhea
- Colic Pain
- Stagnant Weight

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4. Celiac disease is a digestive disorder caused by an abnormal immune reaction to gluten. Celiac disease is also known as:
   - Sprue
   - Non-tropical Sprue
   - Gluten-Sensitive Enteropathy
5. Gluten is a protein found in foods made with wheat, barley, rye, and triticale. It is also found in oats that have been made in processing plants that handle other grains.
6. Villi are tiny finger-like protrusions inside the small intestines. When the villi get damaged, the body is unable to absorb nutrients from food. This can lead to malnutrition and other serious health complications, including permanent intestinal damage.
7. The treatment for celiac disease needs to be nutritionally balanced for age and requires the elimination of gluten which is a protein found in wheat, rye and barley from the diet.
8. Inflammatory Bowel Disease (IBD) is chronic, idiopathic considered a debilitating disorder of the gastrointestinal tract. It may occur during childhood or adolescence in up to 25% of cases and a small percentage of children may present with irritable bowel disease in infancy. The clinical presentation of irritable bowel disease in infants includes symptoms of chronic diarrhea leading to failure to thrive with hematochezia, perianal disease, oral ulcerations, and small bowel obstruction.
9. There are two kinds of Irritable Bowels Disease (IBD):
   - Crohn's Disease
   - Ulcerative Colitis
10. Irritable Bowel Disease (IBD) is probably due to interaction of three essential factors:
    - Genetic susceptibility
    - Environment – local environment, gut micro flora, nutrition environment
    - Immune response of the infant
11. The prevalence of functional constipation is a common problem in children is 3% globally and in 17% to 40% of children, constipation starts in the first year of life. Constipation can be associated with infrequent or probably painful defecation, fecal incontinence, and abdominal pain that cause significant distress to the child and family and has a significant impact on

NOTES

health care cost. Pediatric constipation may have several etiologies, in most children presenting with this symptom no underlying medical disease responsible for the symptom can be found.

12. The problem of constipation can be avoided by the parents in the children by teaching them a healthy toilet regimen with dedicated time for defecation. A child needs to be taught a routine scheduled toilet sitting for 3 min to 10 min at least, once or twice a day with a footstool to support their legs effectively so as to increase intra-abdominal pressure. Parents should avoid punishment for not clearing bowels during the toileting time and praise for the behaviour of toilet sitting can be offered.
13. A balanced diet that includes whole grains, fruits and vegetables is recommended as part of the treatment of constipation in children. Carbohydrates (especially sorbitol) found in prune, pear and apple juices can cause increased frequency and water content in stools.
14. Unabsorbed lipids are transported to the colon where they get utilized by the colonic microbiota.

12.4 SUMMARY

- Lactose intolerance is a digestive disorder caused by the inability to digest lactose, the main carbohydrate in dairy products.
- Lactose intolerance is the condition when infants complain of uncomfortable digestive symptoms of bloating, flatulence and diarrhea after consumption of feeds that contain lactose from dairy.
- Lactose is the carbohydrate which is naturally found in dairy products like milk and milk products cheese, curd and ice cream.
- The indigestion due to lactose intolerance is due to the lactose mal absorption because the small intestines cannot digest the lactose present in milk and milk products which are primarily due to deficiency or absence of lactase enzyme.
- Congenital alactasia is a genetic lactase deficiency disorder in which the infants gut is incapable or unable to break down the lactose in the breast milk or formula milk.
- Lactose intolerance causes severe diarrhea in infants, which is different from milk allergy, as milk allergy is an immune system disorder.
- While treating lactose intolerance investigators need to be verify the symptoms as an infant not gaining weight, recurrent diarrhoea, recurrent abdominal pain or vomiting are associated features of lactose intolerance.
- Primary lactose intolerance requires a lactose-free diet that needs to be continued for a prolonged period of time.

NOTES

- Secondary lactose intolerance following an episode of diarrhoea or dysentery is a transient phase and milk-based feeds can be stopped during this span.
- Usually, children recover from secondary lactose intolerance and, after a while, they can start digesting lactose.
- Lactose intolerance in the infant can occur anytime and not just during the weaning period.
- If a child has been weaned, lactose can be eliminated easily as by then, solid diet has been usually introduced.
- If the child is diagnosed with lactose intolerance when he is predominantly milk fed, then a lactose-free formula needs to be introduced.
- Celiac disease is a digestive disorder caused by an abnormal immune reaction to gluten.
- Gluten is a protein found in foods made with wheat, barley, rye, and triticale. It is also found in oats that have been made in processing plants that handle other grains.
- Gluten can even be found in some medicines, vitamins, and lipsticks. Gluten intolerance, also known as gluten sensitivity, is characterized by the body's inability to digest or break down gluten.
- In Celiac disease, the immune response to gluten creates toxins that destroy the villi.
- Villi are tiny finger-like protrusions inside the small intestines.
- When the villi get damaged, the body is unable to absorb nutrients from food. This can lead to malnutrition and other serious health complications, including permanent intestinal damage.
- In India, gluten in diet is introduced between the age 4 and 6 months in infants, as per recommendations of exclusive breast feeding till age of 6 months and initiating weaning with gluten free foods.
- In infants there is a marked risk of developing food allergies, there is clear evidence that introducing solid foods before the end of the 3rd month is detrimental and should be avoided.
- Breastfeeding at the time of gluten introduction will benefit by delayed appearance of celiac disease which reduces predominant gastrointestinal presentation of celiac disease.
- The treatment for celiac disease needs to be nutritionally balanced for age and requires the elimination of gluten which is a protein found in wheat, rye and barley from the diet.
- Inflammatory Bowel Disease is chronic, idiopathic considered a debilitating disorder of the gastrointestinal tract. It may occur during childhood or adolescence in up to 25% of cases and a small percentage of children may present with irritable bowel disease in infancy.

NOTES

- The clinical presentation of irritable bowel disease in infants includes symptoms of chronic diarrhea leading to failure to thrive with hematochezia, perianal disease, oral ulcerations, and small bowel obstruction.
- In Crohn's disease the layers of the intestinal wall become sore, inflamed, and swollen that can affect any part of the digestive tract, including the mouth, esophagus, stomach, small intestines, large intestines as well as the anus.
- In ulcerative colitis inflammation in only the inner lining of all or part of the colon and rectum and sometimes, only the rectum is affected.
- Infants feeding habits of excessive consumption of cow's milk, the consumption of high quantities of refined sugar and fat and the low consumption of dietary fiber, fruit and vegetables are risk factors to irritable bowels disease.
- The consumption of cow's milk needs to be implicated in the etiology of irritable bowel disease, and these patients show higher levels of serum antibodies against cow's milk protein compared to healthy controls.
- Nutrition therapy plays a fundamental role in the clinical management of pediatric care for children with irritable bowel disease.
- The main objective of nutrition therapy is to correct macro and micronutrient deficiencies in malnourished infants due to increased oxidative catabolism and to reverse the physiopathological consequences of nutrition deficiencies as well as to exert anti-inflammatory therapeutic effect.
- Crohn's disease patients frequently undergo resection of the terminal ileum, and if a large segment of bowel is removed malabsorption of these lipid diet components may appear.
- Omega-3 fatty acids derived from fish oils have been shown to be of benefit in a double-blind Randomized Controlled Trial (RCT) that looked at patients with distal ulcerative colitis.
- Dietary fiber has been investigated as a means of increasing Short-Chain Fatty Acid (SCFA) production. Irritable bowel disease has been linked with impaired SCFA production.
- A high intake of sugar has been shown linked to Crohn's disease in a number of trials, hence its possible etiological role has led to therapeutic trials of sugar avoidance.
- The prevalence of functional constipation is a common problem in children is 3% globally and in 17% to 40% of children, constipation starts in the first year of life.
- Constipation can be associated with infrequent or probably painful defecation, fecal incontinence, and abdominal pain that cause significant distress to the child and family and has a significant impact on health care cost.

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- Pediatric constipation may have several etiologies, in most children presenting with this symptom no underlying medical disease responsible for the symptom can be found.
- Functional constipation is commonly observed in children trying to withhold feces who want to avoid painful defecation.
- A balanced diet that includes whole grains, fruits and vegetables is recommended as part of the treatment of constipation in children.
- Carbohydrates (especially sorbitol) found in prune, pear and apple juices can cause increased frequency and water content in stools.
- Lipids are a broad group of small molecules of fat inclusive of Triacylglycerols (TAGs), hydrophobic or amphiphilic compounds, such as Phospholipids (PLs), Monoacylglycerols and Diacylglycerols (MAGs and DAGs) as well as sterols.
- Investigating from the stool samples of infants it is seen that lipids are not completely absorbed by infant's gut.
- Unabsorbed lipids are transported to the colon where they get utilized by the colonic microbiota.
- Fat malabsorption can cause a change in the stools which is called steatorrhea.
- Asphyxiated infants may have increased secretion of arginine vasopressin (which is likened to Syndrome of Inappropriate Antidiuretic Hormone Secretion (SIADH) and are thought to be at increased risk for cerebral edema.
- Infants of diabetic mothers receive intravenous glucose because of increased danger of hypoglycemia; however, they frequently do not receive sodium and have been found to develop rather substantial hyponatremia at 24 hours if this is not added at or before this time.
- Fluid therapy for the neonate can be rationally planned if several physiologic concepts are kept in mind.
- The surface of the newborn is large and increases with decreasing size; therefore there is a greater probability of excess Insensible Water Loss (IWL), which may be exaggerated as birth weight and gestational age decrease and open radiant warmers rather than incubators are used.

12.4 KEY WORDS

- **Lactose intolerance**: Lactose intolerance is a digestive disorder caused by the inability to digest lactose, the main carbohydrate in dairy products.
- **Celiac disease**: Celiac disease is a digestive disorder caused by an abnormal immune reaction to gluten.

- **Encopresis:** Recurrent episodes of fecal incontinence due to overflow caused by fecal impaction known as encopresis.
- **Villi**: Villi are tiny finger-like protrusions inside the small intestines.
- **Ulcerative colitis**: Ulcerative colitis is the inflammation of inner lining of all or parts of colon and rectum and sometimes, only the rectum is affected.
- **Steatorrhea:** Fat malabsorption can cause a change in the stools which is called steatorrhea.

12.6 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What is lactose intolerance?
2. How is lactose intolerance treated?
3. What is celiac disease and how it is treated?
4. What is Inflammatory Bowel Disease (IBD)?
5. Distinguish between Crohn's disease and ulcerative colitis.
6. What is elementary diet?
7. How is omega-3 fatty acids derived?
8. What are the ways in which fat absorption test diet of infants is conducted?
9. What is the fecal fat test?
10. How is postoperative abdominal surgery conducted?

Long-Answer Questions

1. Explain about lactose intolerance, its causes and treatment.
2. Discuss about celiac disease and its treatment in detail.
3. Explain about Inflammatory Bowel Disease (IBD), its causes, types and treatment.
4. Elaborate a note on enteral *vs* parenteral feeding.
5. Discuss about constipation in children, its behavioural and dietary modification.
6. Describe the fat absorption test diet of infants.
7. Discuss about infant lipid digestion and microbiota composition**.**
8. Analyse the calculation of fluids and electrolytes-both deficit and maintenance and management of calorie intake.
9. Explain fluid and electrolyte management in newborn.

12.7 FURTHER READINGS

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UNIT 13 NUTRITIONAL MANAGEMENT FOR CHILDREN WITH SPECIAL CONDITIONS

Structure

13.0 Introduction
13.1 Objectives
13.2 Nutritional Management for Children with Special Conditions
    13.2.1 Nutrition Management in Autism
    13.2.2 Nutrition Management in Epilepsy
    13.2.3 Nutrition for HIV/AIDS Infected Infants and Children
    13.2.4 Nutrition Management in ADH
13.3 Answers to Check Your Progress Questions
13.4 Summary
13.5 Key Words
13.6 Self Assessment Questions and Exercises
13.7 Further Readings

13.0 INTRODUCTION

Nutrition for kids is based on the same principles as nutrition for adults. Everyone needs the same types of nutrients, such as vitamins, minerals, carbohydrates, protein and fat. Children, however, need different amounts of specific nutrients at different ages. Feeding children nutritious food can be a challenge under the best of circumstances. When a child is not feeling well, these challenges can multiply. This may leave parents feeling uncertain about how best to support growth and development.

Children with chronic diseases are just as unique in their preferences and eating plans as children without chronic disease. The nature and severity of their health condition, age, sex, treatment plans, activity levels and many other factors play a role in nutrition needs. For example, some children with cancer have trouble eating enough to stay at a healthy weight, while other children especially after treatment ends face a higher risk of becoming overweight or obese.

For children with conditions that directly affect the digestive tract, nutrition and medication needs may change over time. For instance, kids with cystic fibrosis nearly always need to take digestive enzymes with meals and snacks. How many and which types of enzymes may vary from case to case, and what worked in the past may need to be adjusted as a child grows, matures and food preferences change. For children who are not eating enough, the sooner you address the issue,

the better. Even a small amount of weight loss or failure to gain weight as expected may negatively affect growth and development. Some medications increase the need for specific nutrients.

If your child needs specialized nutrition support, one of the best things you can do is express confidence in the decisions you and your child's health care team have made. Fear of the unknown is normal. Discuss these fears and concerns with the RDN. Ask for help as much as needed, and have the RDN or home health care practitioner explain and demonstrate special feeding instructions. Finally, make your child feel included. If the only family time involves food, this can make a child on nutrition support feel left out. Try to build family rituals and family time around activities that do not involve food and meals.

In this unit, you will study about nutritional management for children with special conditions like autism and ADH, i.e., Attention Deficit Hyperactivity Disorder, Epilepsy and AIDS.

13.1 OBJECTIVES

After going through this unit, you will be able to:

- Discuss about nutritional management for children with special conditions
- Understand about autism and its nutritional management
- Explain about ADH, Epilepsy and AIDS and their nutritional management

13.2 NUTRITIONAL MANAGEMENT FOR CHILDREN WITH SPECIAL CONDITIONS

Nutrition for kids is based on the same principles as nutrition for adults. Everyone needs the same types of nutrients, such as vitamins, minerals, carbohydrates, protein and fat. Children, however, need different amounts of specific nutrients at different ages. Many children live with special needs due to disorders, such as cerebral palsy, Attention Deficit Hyperactivity Disorder (ADHD), and autism spectrum disorder. These conditions can affect muscles, senses, and cognitive development, impacting children's oral feeding abilities, self-feeding skills, and sensory system functioning. As a result, their nutrition status may suffer.

13.2.1 Nutrition Management in Autism

Autism is a serious developmental disorder that impairs the ability to communicate and interact. Autism spectrum disorder is a complex developmental disorder and the symptoms of autism generally appear in the initial years of life that will manifest throughout the child's life into adulthood indicating significant delays or deviation in interaction and communication.

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Autism is Characterized By

Autism is characterized by the following points:

- Social Isolation
- Repetitive Behaviour
- Compulsive Obsessive Behaviour
- Communication Lapse Verbal or Non-Verbal
- Repetitive Movements, such as Rocking or Flopping, Hyperactivity
- Lack of Eye Contact
- Resistance to Change
- Sleep Disorders

The multidisciplinary approach to assist children with autism will include prescribing:

- Psychotropic Drugs
- Chelation Therapy
- Hyperbaric Oxygen Therapy
- Educational Therapy
- Speech and Pronunciation Exercises
- Social Skills Therapy
- Occupational Therapy
- Physical Therapy
- Medical Nutrition Therapy

Nutrition Management In Autism

In children with Autism, the nutritionist has to understand that the problems affecting the GastroIntestinal System (GIS), that include complaints of constipation, diarrhea, and steatorrhoea as well as predominant failure to adapt to medication and nutritional status along with food allergies and food intolerance, metabolic disorders, nutritional deficiencies due to probable eating disorders, behaviour eating tantrums, extreme picky eating along with dealing with stubborn behaviour involving a refusal to eat, food obsessions. Unresponsive to verbal or non-verbal cues and hyperactivity, are hindrances in planning nutrition in children with autism spectrum disorder.

Autism spectrum disorder affected children may indicate these the most common deficiencies are of:

- Iron
- Methylcobalamin
- Calcium
- Selenium

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- Iodine
- Magnesium
- Chromium
- Vitamin A
- Thiamine
- Niacin
- Pantothenic Acid
- Biotin
- Omega-3 Fatty Acids

Autism in children may adversely affect the vitamin and mineral balance in the body, because inflammation in the intestines that interferes with vitamin and mineral absorption and hence supplementation helps to decrease certain cognitive concerns, sleep issues, and gastro intestinal problems.

In Autism, there is a decrease in the probiotics in the gut flora that is known to adversely impact due to the synthesis of vitamin K, biotin and niacin in the body.

Current Dietary Approaches in Autism Spectrum Disorder Ketogenic Diet

Anti-epileptogenic clinical use of the ketogenic diet is very low in carbohydrates but high in fat, and sufficient in protein. It is clinically being used due to the observed effectiveness of the diet in controlling the drug-resistant seizures. There has been a medically linking of autism to metabolic disorders with similar traits to epilepsy, and syndromes, such as the Landau Kleffner, Dravet as well as Rett syndromes. With the ketogenic diet a predominant increased serum ketones, decreased serum glucose and increased mitochondrial functions due to specific metabolic effects of the diet have been observed.

Gluten-Free Casein-Free Diet

The new school of thought believes that gluten and casein peptides trigger an immune response resulting in gastro intestinal inflammation. The effects of gluten and casein on immunology pathways have been claimed to cause autism and it has been determined that gluten and casein peptides trigger abnormal cytokine production, cause defects in immunology pathways, and cause damage to the central nervous system. In theory, there is a belief that gluten free casein free can play a role in suppressing allergic responses and probably help in brain development while restoring the brain functions by impacting neural functions.

Observations show that adherence to this gluten free casein free diet has clinical reduction in symptoms with better gastro intestinal health along with improvement in speech and communication skills with a decrease in hyperactive behaviour while improving attention and focus as well as decrease in sleeps problems.

High-Fat Diet

Recent studies have linked changes in the dopamine mechanism caused by a high-fat diet to certain behaviours related to autism, such as reward sensitivity, learning and memory, anxiety-related behaviours, social interaction, motivation and reward processing.

Cognitive and social problems are thought to be aggravated by a high fat diet, its effects stated to be a result of the dopaminergic mechanism. The fact that high fat diet resulted in a decrease in the dopamine signals in the hypothalamus, causing dopamine dysfunction that may lead to dysfunctions in areas of the nervous system that control behaviour in addition to other areas. These effects may be the reason why it is stated that high fat diet can cause behavioural defects related to autism.

Difference Between

The Ketogenic Diet is a diet that includes a high level of fat and extremely low level of carbohydrates at a low level of protein - Energy kcal: 90% fat, 7% protein, 3% carbohydrates.

The High Fat Diet is a diet that includes a large amount of fat, a sufficient amount of protein and a low level of carbohydrates: Energy kcal: 60% fat, 20% protein, 20% carbohydrate.

Novel approaches in nutrition, such as the Fermentable Oligosaccharides, Disaccharides, Monosaccharides, and Polyols diet (FODMAP), the Specific Carbohydrate Diet, elimination and avoiding food additives, have led to certain improvements in individuals with autism.

The Feingold diet, which eliminates artificial food colouring, artificial sweeteners, preservatives, and substances, such as aspartame, neotame, and alitame, has been also practiced for benefit of children with autism.

Curcumin

Curcumin is reported to have positive effects on the treatment of autism due to such characteristics as increasing intracellular GSH levels, reducing inflammatory components, counteracting the damage caused by heavy metals, positively impacting the treatment of viral and fungal infections and supporting liver detoxification.

Probiotics

Probiotics are reported to improve diarrhoea and constipation symptoms in autism in children, but they should not be used in autistic children with compromised immune systems.

Food Additives

The consumption of foods high in fructose is discouraged, since it is also believed to trigger the formation of oxalate stones.

Camel Milk

Camel milk has a unique composition that differs from other dairy. Compared to cow's milk, it contains more minerals (calcium, iron, magnesium, copper, zinc, and potassium), more vitamins (A, B2, E, and C), less fat, less cholesterol, and less lactose. It also lacks beta-lactoglobulin and betacasein, which are basic active components of cow's milk allergy.

Furthermore, camel milk contains various protective proteins and enzymes with antibacterial, antiviral, and immunological properties.These enzymes include immunoglobulins, lysozymes, lactoferrin, lactoperoxidase, N-acetyl-β-glucosaminidase, and peptidoglycan recognition protein, which are essential in preventing food allergies and rehabilitating the immune system. Camel milk owes its potential efficacy in the treatment of food allergies to its inflammation-inhibiting proteins, hypoallergenic properties, and smaller nanobodies and can improve some core autistic symptoms with its hypoallergenic properties and antibodies, which are similar to human antibodies.

It is reported that in individuals with autism, while the gluten-free casein-free, ketogenic diet, camel milk, curcumin, probiotics, and fermentable foods can play a role in alleviating autism symptoms, the consumption of sugar, additives, pesticides, genetically modified organisms, inorganic processed foods, and difficult-to-digest starches may aggravate symptoms.

In a medical nutrition therapy approach, it is beneficial to examine the pathophysiology, food intake, food allergies/intolerances, and nutritional behaviours of the individual with autism to supplement the energy and nutrient deficiencies with food, to ensure a sufficient and balanced diet and to adopt a therapeutic diet approach to alleviate symptoms.

Source: Nutritional Neuroscience August 2017

13.2.2 Nutrition Management in Epilepsy

Epilepsy is a disorder in which nerve cell activity in the brain is disturbed, causing seizures. Dietary therapies represent a potentially valuable adjunct to other epilepsy treatments, such as anticonvulsant medications, epilepsy surgery, and vagus nerve stimulation. Although the ketogenic diet (high fat, adequate protein, low carbohydrate) is the most well-established dietary therapy for epilepsy, other possible approaches include the Atkins diet (high fat, high protein, low carbohydrate), a diet enriched in polyunsaturated fatty acids, or overall restriction of calorie intake.

The Ketogenic Diet (KD) is certainly the best-known dietary approach to epilepsy treatment, as well as other dietary therapies, including the Atkins diet, calorie restriction, and a diet enriched in polyunsaturated fatty acids.

Ketogenic Diet (KD)

The clinical efficacy of the Ketogenic Diet (KD) has been verified in numerous studies, both in the United States and international. The KD is effective in people of all ages, although it may be maximally effective in the toddler and school-age child. Observation suggest that the KD might be both anticonvulsant and antiepileptogenic.

When switching from a diet high in carbohydrates to one high in fats and with stringent carbohydrate restriction, the body uses fats as the primary energy source. Fat breakdown in the liver creates ketone bodies (β-hydroxybutyrate, acetoacetate, and acetone), which circulate to the brain and are taken up into cerebral tissue via specific monocarboxylate transporters. In neuronal mitochondria, ketones are metabolized to Adenosine Triphosphate (ATP) via the tricarboxylic acid cycle and oxidative phosphorylation. The challenge has been to understand how this energy shift results in an anticonvulsant effect. Obviously, multiple sites exist in the relevant biochemical pathways at which seizure suppression could be facilitated, and the mechanism (or more likely, mechanisms) by which the KD exerts an anticonvulsant effect likely involves the combination of the altered energy homeostasis and regulation of neuronal and synaptic excitability.

Atkins Diet: Atkins diet induces a state of ketosis by providing high fat and little carbohydrate, it is theoretically possible that the Atkins diet could enable seizure control by a mechanism similar to that of the Ketogenic Diet (KD). Two main differences are found between the diets:

- Atkins diet does not restrict calories.
- Atkins diet allows large amounts of protein, which is restricted on the KD.

The following Table 13.1 shows the comparison of ketogenic and atkins diets.

Table 13.1 *Comparison of Ketogenic and Atkins Diets*

Diet Composition	Ketogenic Diet	Atkins Diet
Fat (% by Weight)	80	60
Protein (% by Weight)	15	30
Carbohydrate (% by Weight)	5	10
Calories (% Recommended Daily Allowance)*	75	Not Restricted

The original idea for a Ketogenic Diet (KD) was derived from the beneficial effect that fasting had on seizures, and this observation has been verified in the modern setting. This approach, was impractical except for very short-term use. Nevertheless, the health benefits of modest calorie restriction are increasingly and include increased life span, reduced risk of cancer and cardiovascular disease, and amelioration of the degenerative affects of aging. Restriction of calorie intake also can be neuroprotective. Children on the KD are typically restricted to 75% of the recommended daily allowance for their ideal weight and height. This calorie

level allows linear growth but prevents significant weight gain. Calorie restriction may facilitate ketosis and exert an anti-seizure effect, independent of ketosis. In individuals on the KD, blood glucose levels are usually in the lower end of normal, but patients are rarely hypoglycemic. Therefore, a metabolic adaptation occurs in response to the KD to maintain relative euglycemia. The main clinical question, as yet unanswered, is whether calorie restriction can reduce the seizure burden independent of ketosis.

Polyunsaturated Fatty Acids

Fatty acids plays a critical role in nervous system development. The essential fatty acids, especially the long-chain Polyunsaturated Fatty Acids (PUFAs) of the ω-3 class (as found in certain fish oils), are necessary for the development of normal retinal and neuronal membranes, as well as for subsequent normal behaviour and cognition. Deficiencies of PUFAs lead to cognitive, behavioural, and structural brain abnormalities. PUFAs play important roles in brain development and in the modulation of neuronal excitability.

Conclusions

Aside from offering common sense, i.e., eat a healthy, well-balanced diet, is it possible to offer epilepsy patients any specific advice regarding nutrition? Unfortunately, our knowledge about the relation between nutrition and epilepsy is in its infancy. Aside from the KD, nutritional modalities to treat epilepsy are premature. Nevertheless, as indicated in this review, several potential treatment adjuncts are on the horizon. Further basic research is necessary before clinical trials are undertaken with these prospective treatments. However, dietary alterations comprise an intriguing and novel approach to epilepsy treatment. Parents should be cautioned not to initiate any of these diets in children without pediatric medical supervision.

13.2.3 Nutrition for HIV/AIDS Infected Infants and Children

- Children HIV/AIDS be routinely assessed for nutritional status as well as weight and height at scheduled clinic visits, particularly after initiation of ART, Antiretroviral Therapy.
- Children on the treatment of ART who are symptomatic, have conditions requiring increased energy, for example TB, chronic lung disease, or have weight loss or evidence of poor growth should be provided with 25 – 30% additional energy.
- Incase the children are severely malnourished are to be managed as per the guidelines for uninfected children and provided with 50 – 100% additional energy.
- The children should receive one Recommended Daily Allowance (RDA) of micronutrients daily incase of AIDs/HIV infection. If this cannot be assured through the diet, or there is evidence of deficiency, then supplementation should be given.

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- The infants and children between 6 and 59 months of age should receive high-dose vitamin A supplementation every 6 months, as per the guidelines for uninfected children.
- Incase the children with diarrhoea should receive zinc supplementation as part of management, as per the guidelines for uninfected children.
- For infants and young children known to be HIV infected, mothers are strongly encouraged to exclusively breastfeed for 6 months and continue breastfeeding as per recommendations for the general population (up to two years of age and beyond).

WHO recommends that nutritional assessment and support be an integral part of the care plan of an HIV-infected infant or child, irrespective of whether the child is on ART (WHO 2009). For further information on poor growth and detailed definitions of growth parameters and appropriate nutritional interventions, reference should be made to the *WHO Guidelines for an integrated approach to nutritional care of HIV-infected children* (6 months – 14 years).

Understanding the Nutritional Profile

Undernutrition: Food intake of insufficient quantity or quality to meet nutritional needs for growth and development.

Poor Growth or Growth: Ideally these should be determined using more than one-time measurements to indicate changes over time and whether a child is following an appropriate growth curve/trajectory. In the absence of several measurements, it is possible to consider proxy measurements, such as:

- Weight-for-age less than -2 z-score (underweight)
- Height-for-age less than -2 z-score (stunting)
- Weight-for-height less than -2 z-score (wasting)
- Mid-Upper Arm Circumference (MUAC) less than -2 z-score

(*Reference:* WHO growth reference charts)

Very Low Weight for Age: Weight-for-age less than -3 z-score.

Weight Loss: Weight loss of >5% since last visit.

Meeting the Energy Needs of Children Living with HIV

At clinic visits, the nutritional needs of children confirmed with HIV should be assessed and a nutritional care plan agreed upon with the mother or caregiver. The assessment should consider the child's growth pattern, appetite, presence of symptoms and any clinical signs of malnutrition.

The children who are growing well, mothers or caregivers are encouraged to provide a balanced diet and counseled on the nutritional value of different foods and general food hygiene.

On the other hand, children showing deficit on growth require a full dietary assessment and drug adherence if the child is on ART. Mothers or caregivers

should be asked about food availability and food types offered to the child, as well as who feeds the child, how much and how often. Children should be examined to detect signs of wasting. Appropriate clinical interventions should be provided. Additional energy can be provided through a combination of increasing the energy density of family foods, increasing the quantity of food consumed each day and providing energy supplements. Mothers or caregivers should be referred to food support programs, if available. Caregivers should also be counselled on how to manage anorexia, alleviate the symptoms of conditions that interfere with normal ingestion or digestion, such as mouth sores, oral thrush and diarrhoea, and ensure adequate energy intake.

In children experiencing growth failure (failure to gain weight, weight loss), feeding difficulties (due to oral thrush, loss of appetite) or malabsorption due to persistent diarrhoea, more targeted support may be necessary. Following acute illnesses when weight loss might have occurred, it is important to prioritize nutritional support and interventions to enable the child to recover nutritionally as well as from the clinical illness. Common illnesses should be managed according to the IMCI guidelines. The *Guidelines for an integrated approach to the nutritional care of HIV-infected children (6 months – 14 years)* provides details of appropriate nutritional interventions.

Meeting the Micronutrient Needs of Children Living with HIV

Adequate micronutrient intake is best achieved through a balanced diet. Caregivers should be counseled on optimum local food choices and preparation methods to ensure maximal micronutrient intake through healthy eating, equivalent to RDA. In situations where appropriate micronutrient intake cannot be achieved, supplementation may be necessary.

Special consideration should be given to the micronutrient intake and status of HIV-infected children experiencing growth failure, OIs or prolonged diarrhoea. HIV-infected children should receive regular vitamin A supplementation and zinc during diarrheal illness according to WHO recommendations. Currently, there are inadequate data to inform the optimal formulation of micronutrient supplements for HIV-infected children.

Managing the HIV Infected Child who has Severe Malnutrition

Severe wasting is a common clinical presentation of HIV infection in children. All children with severe malnutrition are at risk for a number of life-threatening problems and require urgent and appropriate nutritional rehabilitation.

It needs to be emphasized that where malnutrition is endemic, HIV-infected children may become severely malnourished due to a lack of an adequate, balanced diet. In these settings, it is very difficult to differentiate severe malnutrition that is primarily due to HIV infection from other non-HIV causes, including food insecurity and starvation. Children with an unknown HIV status, who present with severe malnutrition in settings where HIV and food insecurity are common, should be tested for HIV and considered for Antiretroviral Therapy (ART).

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Nutritional Considerations for the Child Who is Receiving Antiretroviral Therapy (ART)

Successful viral suppression and immune restitution with Antiretroviral Therapy (ART) can reverse losses in weight and linear growth. Children who gain weight rapidly with ART and adequate nutrition should be reassessed frequently and ARV dosages revised as needed. The recurrence of growth failure and severe malnutrition that is not due to food insufficiency in children receiving ART may indicate treatment failure, non-adherence to ARVs.

Caregivers should be counselled as to potential food interactions with prescribed ART and how to alleviate any drug-related gastrointestinal side-effects. Nutrition counselling and support should aim to enable caregivers to provide a balanced diet that meets energy, protein and micronutrient needs. This should include referral to food programs and micronutrient supplementation to rectify deficiencies.

13.2.4 Nutrition Management in ADH

Attention Deficit Hyperactivity disorder (ADH) is a brain disorder that affects how you pay attention, sit still, and control your behaviour. It happens in children and teens and can continue into adulthood.

ADH is the most commonly diagnosed mental disorder in children. Boys are more likely to have it than girls. It is usually spotted during the early school years, when a child begins to have problems paying attention.

ADH cannot be prevented or cured. But spotting it early, plus having a good treatment and education plan, can help a child or adult with ADH manage their symptoms.

ADH Symptoms

Symptoms in Children

Symptoms are grouped into three types:

Inattentive

Inattentive include as follows:

- Easily distracts
- Does not follow directions or finish tasks
- Does not seem to be listen
- Does not pay attention and makes careless mistakes
- Forgets about daily activities
- Has problems organizing daily tasks
- Does not like to do things that require sitting still
- Often loses things
- Tends to daydream

Hyperactive-Impulsive

Hyperactive-impulsive include as follows:

- Often squirms, fidgets or bounces when sitting
- Does not stay seated
- Has trouble playing quietly
- Always moving, such as running or climbing on things.
- Talks excessively
- Has trouble waiting for their turn
- Blurts out answers
- Interrupts others

Combined: This involves signs of both other types.

Symptoms in Adults

Symptoms of ADH may change as a person gets older they are as follows:

- Often being late or forgetting things
- Anxiety
- Low self-esteem
- Problems at work
- Trouble controlling anger
- Impulsiveness
- Substance misuse or addiction
- Trouble staying organized
- Procrastination
- Easily frustrated
- Often bored
- Trouble concentrating when reading
- Mood swings
- Depression
- Relationship problems

Nutrients Management in ADH

Sugar

The Academy of Nutrition and Dietetics published a position paper in 2012 regarding the use of nutritive and non-nutritive sweeteners. Based on a meta-analysis performed by Wolraich *et al*, and other reviews, the Academy of Nutrition and Dietetics has taken the position that sugar does not affect behaviour or cognition in children with or without ADH. Certainly parental expectations and perceptions

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are a major confounder in research done of this type, and additionally, the research done in this area was poorly designed.

Dietitians working with these children and their families should encourage reduced intake of simple carbohydrates and sugars, while providing education regarding complex carbohydrates and whole grain foods, just as they would with any children when discussing an overall healthy diet.

Omega-3 Polyunsaturated Fatty Acids

Decreased levels of Omega-3 Polyunsaturated Fatty Acids (PUFAs) have been seen in ADH patients, and in some studies supplementation in deficient children led to an improvement in blood levels and behaviour. Additionally, women who consumed an omega-3-rich diet during pregnancy were less likely to have a child with ADH-related behaviour. Similarly, a meta-analysis conducted by Sonuga-Barke *et al*, showed that although statistically significant differences were seen in ADH symptoms with PUFA, it was unclear how the supplements improved clinical outcomes and there was likely very little clinical benefit to supplementation. Overall, while some studies show that supplementation may lead to improvements in some aspects of ADH behaviour, such as attention problems, other studies do not show this positive benefit. Meta-analyses are finding some possible benefit but better randomized controlled trial studies are necessary to find true efficacy if it exists. Dietitians should consider recommending supplementation with omega-3 PUFAs only when a deficiency is confirmed or strongly suspected in the cases of limited dietary intake of PUFAs.

Micronutrients

Limited research has been done on serum levels of zinc, iron, and magnesium in children diagnosed with ADH versus a control population, with general consensus that these values are lower in children with ADH. Appropriate supplementation in children deficient in these nutrients produced small improvements in behaviour. Before recommending micronutrient supplementation, RDs should consult with the patient's physician to develop an overall care plan, and supplement only children who have a verified deficiency.

Food Allergies and Hypersensitivities

Food allergies have been implicated in behavioural and psychological symptoms, including those associated with ADH. Interestingly, psychosocial abnormalities have been reported to lead to food allergies as well. Some reports show that allergic reactions during infancy can predict later neurodevelopmental abnormalities. Overall, the research as to the prevalence of ADH and allergic diseases can be conflicting, but the general consensus is that even if a relationship does exist, a cause and effect relationship cannot be established yet.

It has been reported that up to 12% of children diagnosed with ADH are using complementary and alternative medicine to treat the ADH, such as using elimination diets and/or avoidance of hyperallergenic foods, such as egg, milk, wheat, chocolate, and nuts.

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Artificial Food Colorings and Food Preservatives

The issue of the effect of food colorings and preservatives on childhood behaviour was first popularized in the 1970s by Fiengold when he published the Kaiser Permanente diet. Many researchers then tried to test this diet, with inconsistent results. Similar to research conducted on other food components, the outcomes of studies done comparing the behaviour of children with ADH when artificial food colorings and/or food preservatives are eliminated from the diet is conflicting. When consulted to determine whether to implement a diet eliminating these very prevalent food components to improve ADH behaviour, dietitians should have conversations with parents about the pros and cons of attempting this in the setting of managing other lifestyle and behavioural management components of ADH.

Eating Behaviour

In 2014, Ptacek *et al*, investigated eating behaviour and lifestyle factors that may explain the increased incidence of obesity in children diagnosed with ADH. Eating habits were assessed from structured interviews of parents of boys aged 6 to 10 years, comparing 100 boys diagnosed with ADH to 100 age-matched controls. None of the subjects were taking psychostimulant medications for treatment of ADH symptoms. Although there is no standardized questionnaire suitable for the purpose of this type of study, parental report of behaviour in ADH children is considered to be the most reliable source of information for this patient population.

This research demonstrated that ADH children frequently skip meals more often than control children, yet they eat more than 5 times per day. Therefore, they eat on a less defined schedule but more frequently. Children with ADH also drink more sugar sweetened beverages than children in the control group, accounting for almost half of daily fluid intake. Parents of ADH children were less likely to report that their children ate fruits and vegetables than parents of children without ADH. Further compounding the problem is the fact that ADH children spent more hours watching television or playing on a computer than children in the non-ADH group. Children in the non-ADH group spent on average 2 hours more per day in sports activities.

Check Your Progress

1. What is autism?
2. How is autism characterized?
3. What are the most common deficiencies that are shown by children affected with autism spectrum disorder?
4. Define the term ketogenic diet.
5. What is epilepsy?
6. What does atkins diet do?
7. What is ADH? How does it happen?
8. List the symptoms that are shown in ADH inattentive.

13.3 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

NOTES

1. Autism is a serious developmental disorder that impairs the ability to communicate and interact. Autism spectrum disorder is a complex developmental disorder and the symptoms of autism generally appear in the initial years of life that will manifest throughout the child's life into adulthood indicating significant delays or deviation in interaction and communication.
2. Autism is characterized by the following points:
    - Social Isolation
    - Repetitive Behaviour
    - Compulsive Obsessive Behaviour
    - Communication Lapse Verbal or Non-Verbal
    - Repetitive Movements, such as Rocking or Flopping, Hyperactivity
3. Autism spectrum disorder affected children may indicate these the most common deficiencies are of:
    - Iron
    - Methylcobalamin
    - Calcium
    - Selenium
    - Iodine
    - Magnesium
    - Chromium
    - Vitamin A
4. The ketogenic diet is a diet that includes a high level of fat and extremely low level of carbohydrates at a low level of protein - Energy kcal: 90% fat, 7% protein, 3% carbohydrates.
5. Epilepsy is a disorder in which nerve cell activity in the brain is disturbed, causing seizures.
6. Atkins diet induces a state of ketosis by providing high fat and little carbohydrate, it is theoretically possible that the Atkins diet could enable seizure control by a mechanism similar to that of the Ketogenic Diet (KD).
7. Attention Deficit Hyperactivity disorder (ADH) is a brain disorder that affects how you pay attention, sit still, and control your behaviour. It happens in children and teens and can continue into adulthood. ADH is the most commonly diagnosed mental disorder in children. Boys are more likely to

have it than girls. It is usually spotted during the early school years, when a child begins to have problems paying attention.

8. ADH symptoms in inattentive include as follows:
   - Easily distracts
   - Does not follow directions or finish tasks
   - Does not seem to be listen
   - Does not pay attention and makes careless mistakes
   - Forgets about daily activities
   - Has problems organizing daily tasks
   - Does not like to do things that require sitting still
   - Often loses things
   - Tends to daydream

13.4 SUMMARY

- Autism is a serious developmental disorder that impairs the ability to communicate and interact.
- Autism spectrum disorder is a complex developmental disorder and the symptoms of autism generally appear in the initial years of life that will manifest throughout the child's life into adulthood indicating significant delays or deviation in interaction and communication.
- In children with Autism, the nutritionist has to understand that the problems affecting the GastroIntestinal System (GIS), that include complaints of constipation, diarrhea, and steatorrhoea as well as predominant failure to adapt to medication and nutritional status along with food allergies and food intolerance, metabolic disorders, nutritional deficiencies due to probable eating disorders, behaviour eating tantrums, extreme picky eating along with dealing with stubborn behaviour involving a refusal to eat, food obsessions.
- Unresponsive to verbal or non-verbal cues and hyperactivity, are hindrances in planning nutrition in children with autism spectrum disorder.
- Autism in children may adversely affect the vitamin and mineral balance in the body, because inflammation in the intestines that interferes with vitamin and mineral absorption and hence supplementation helps to decrease certain cognitive concerns, sleep issues, and gastro intestinal problems.
- In Autism, there is a decrease in the probiotics in the gut flora that is known to adversely impact due to the synthesis of vitamin K, biotin and niacin in the body.
- Anti-epileptogenic clinical use of the ketogenic diet is very low in carbohydrates but high in fat, and sufficient in protein.

- The effects of gluten and casein on immunology pathways have been claimed to cause autism and it has been determined that gluten and casein peptides trigger abnormal cytokine production, cause defects in immunology pathways, and cause damage to the central nervous system.
- The ketogenic diet is a diet that includes a high level of fat and extremely low level of carbohydrates at a low level of protein - Energy kcal: 90% fat, 7% protein, 3% carbohydrates.
- The high fat diet is a diet that includes a large amount of fat, a sufficient amount of protein and a low level of carbohydrates: Energy kcal: 60% fat, 20% protein, 20% carbohydrate.
- Curcumin is reported to have positive effects on the treatment of autism due to such characteristics as increasing intracellular GSH levels, reducing inflammatory components, counteracting the damage caused by heavy metals, positively impacting the treatment of viral and fungal infections and supporting liver detoxification.
- Probiotics are reported to improve diarrhoea and constipation symptoms in autism in children, but they should not be used in autistic children with compromised immune systems.
- The consumption of foods high in fructose is discouraged, since it is also believed to trigger the formation of oxalate stones.
- Camel milk has a unique composition that differs from other dairy.
- Compared to cow's milk, camel's milk contains more minerals (calcium, iron, magnesium, copper, zinc, and potassium), more vitamins (A, B2, E, and C), less fat, less cholesterol, and less lactose. It also lacks beta-lactoglobulin and beta casein, which are basic active components of cow's milk allergy.
- A disorder in which nerve cell activity in the brain is disturbed, causing seizures.
- The Ketogenic Diet (KD) is certainly the best-known dietary approach to epilepsy treatment, as well as other dietary therapies, including the Atkins diet, calorie restriction and a diet enriched in polyunsaturated fatty acids.
- The clinical efficacy of the Ketogenic Diet (KD) has been verified in numerous studies. The KD is effective in people of all ages, although it may be maximally effective in the toddler and school-age child.
- When switching from a diet high in carbohydrates to one high in fats and with stringent carbohydrate restriction, the body uses fats as the primary energy source.
- In neuronal mitochondria, ketones are metabolized to Adenosine Triphosphate (ATP) via the tricarboxylic acid cycle and oxidative phosphorylation.

- Atkins diet induces a state of ketosis by providing high fat and little carbohydrate, it is theoretically possible that the Atkins diet could enable seizure control by a mechanism similar to that of the Ketogenic Diet (KD).
- The original idea for a Ketogenic Diet (KD) was derived from the beneficial effect that fasting had on seizures, and this observation has been verified in the modern setting.
- Fatty acids play a critical role in nervous system development. The essential fatty acids, especially the long-chain Polyunsaturated Fatty Acids (PUFAs) of the ω-3 class (as found in certain fish oils), are necessary for the development of normal retinal and neuronal membranes, as well as for subsequent normal behaviour and cognition.
- Attention Deficit Hyperactivity disorder (ADH) is a brain disorder that affects how you pay attention, sit still, and control your behaviour. It happens in children and teens and can continue into adulthood.
- ADH is the most commonly diagnosed mental disorder in children. Boys are more likely to have it than girls. It is usually spotted during the early school years, when a child begins to have problems paying attention.
- ADH cannot be prevented or cured. But spotting it early, plus having a good treatment and education plan, can help a child or adult with ADH manage their symptoms.

13.5 KEY WORDS

- **Autism**: Autism is a serious developmental disorder that impairs the ability to communicate and interact.
- **Epilepsy**: Epilepsy is a disorder in which nerve cell activity in the brain is disturbed, causing seizures.
- **ADH:** Attention Deficit Hyperactivity disorder (ADH) is a brain disorder that affects how you pay attention, sit still, and control your behaviour.
- **Ketogenic diet:** The ketogenic diet is a diet that includes a high level of fat and extremely low level of carbohydrates at a low level of protein - Energy kcal: 90% fat, 7% protein, 3% carbohydrates.

13.6 SELF-ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What are the characteristic of autism?
2. What are the most common deficiencies caused in autism?
3. Distinguish between ketogenic diet and high-fat diet.

NOTES

4. How does probiotics help in autism?
5. What is the nutritional profile of an infant that is suffering from HIV/AIDS?
6. How is energy needs of children suffering from HIV met?
7. What are the different types of symptoms that are shown in ADH?

Long-Answer Questions

1. Discuss about nutritional management for children with special conditions.
2. Explain nutrition management in autism.
3. Describe about current dietary approaches in autism spectrum disorder ketogenic diet.
4. Elaborate a note on nutrition management in epilepsy.
5. How is ketogenic diet different from atkins diet? Explain.
6. Discuss about the nutrition for HIV/AIDS infected infants and children.
7. Explain the nutritional considerations for the child who is Receiving Antiretroviral Therapy (ART).
8. Write a descriptive note on nutrition management in ADH.

13.7 FURTHER READINGS

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NOTES

UNIT 14 MEASURING AND PLOTTING GROWTH OF INFANTS

Structure

14.0 Introduction
14.1 Objectives
14.2 Measuring, Recording and Plotting Growth of Infants
14.3 Answers to Check Your Progress Questions
14.4 Summary
14.5 Key Words
14.6 Self Assessment Questions and Exercises
14.7 Further Readings

14.0 INTRODUCTION

Growth assessment is the most useful tool for defining health and nutritional status at both the individual and population level. This is because disturbances in health and nutrition, regardless of their etiology, almost always affect growth. Growth monitoring strives to improve nutrition, reduce the risk of inadequate nutrition, educate caregivers, and produce early detection and referral for conditions manifested by growth disorders. At the population health level, cross-sectional surveys of anthropometric data help define health and the nutritional status for purposes of program planning, implementation and evaluation. Growth monitoring is also used in all settings to assess the response to intervention.

Recent changes to commonly used growth charts, including the addition of charts for Body Mass Index (BMI), have raised questions about which growth charts to use for Canadian children and how to apply BMI in the paediatric population.

From birth, the baby's height is recorded so that their growth can be monitored. These measurements are generally recorded on a growth chart. Sometimes it can be hard to tell if your baby or child is growing well and at what rate. As you are with them all the time, small changes in height and development are not always noticed. Clothes sizes can vary considerably, so the best way to monitor growth is by measuring height and recording it using a growth chart. Once you have your child's height it is a good idea to keep a record of it so you can see how it is changing over time. Children grow at different rates and keeping a log of how your child's height changes will help you see any height changes as well as

growth spurts. Pre-printed growth charts often show a range of heights so you can see where your child's height fits on the scale compared with the average height of other children in his or her age group.

NOTES

In this unit, you will study about measuring, recording and plotting growth of infants.

14.1 OBJECTIVE

After going through this unit, you will be able to:

- Analyse how growth of infants is measured
- Discuss the recording of growth of infants
- Understand how the growth of infants is plotted

14.2 MEASURING, RECORDING AND PLOTTING GROWTH OF INFANTS

Measuring a Child's Growth

The child's age, sex and measurements of weight and length or height will be used to calculate the following growth indicators:

- Length/Height for Age
- Weight for Age
- Weight for Length/Height
- Body Mass Index (BMI) for Age

The measurements of a child is taken and recorded whenever an infant or child visits a health care provider, for example for an immunization, a well-baby visit, or care during an illness. There is no World Health Organisation (WHO) recommended schedule of visits specifically for growth assessment, but some countries may recommend a schedule, such as 6 visits in the first 2 years of life.

Use the Growth Record

A growth record is a booklet that contains all of the charts needed to record and assess the growth of a child from birth up to 5 years of age. A different growth record is needed for boys and girls because boys and girls have different weights and lengths beginning at birth. Boys and girls need to be assessed by standards that reflect normal differences in their sizes (Refer Figure 14.1).

NOTES



Fig. 14.1 Growth Record of Boys and Girls

A growth record should be started for each child and kept by the mother. When a child visits the health facility, ask the mother if the child has a growth record.

If a child's growth record has been left at home, record information on whatever back-up register or record is available at the health facility, and update the child's growth record at the next visit. If a child's growth record is lost or destroyed, replace it if supplies permit.

Start a New Growth Record

Depending on the sex of the child, select a boy's growth record or girl's growth record. Show the growth record to the mother and explain the following points:

- Growth record booklet records the growth and health child.
- Each time a child is taken for a visit he is weighed and measured, and the measurements are recorded in the booklet.
- The booklet includes charts on which the child's measurements are plotted in order to assess his or her growth.
- It has a schedule of immunizations to show when the child needs to receive immunizations.
- It has recommendations about feeding the child and important points about caring for child at different ages.
- This booklet needs to be kept in a safe place and bring it with you whenever you bring your child to a health facility.

The page 1 of the growth record is filled with personal data by asking questions about mother and reviewing any relevant documents that the mother may have, such as a health card or birth certificate.

NOTES

Personal Data

Child's name ______________________________ ←Boy *If a girl, must use a Girl's Growth Record*

Identification/Record number______________________

Parents' names ______________________________

____

Address ______________________________

____

Birth information:

Date of birth ____________________ Gestational age at birth

____________________ Single/multiple birth? __________

Measurements at birth:

Weight__________ Length__________ Head circumference __________

Birth rank __________

Date of birth of next younger sibling (born to mother)__________

Feeding:

Age at introduction of any foods or fluids ____________

Age at termination of breastfeeding ____________

More details of feeding history may be recorded in Visit Notes

Adverse events (dates):

(Such as, death of parent, death of sibling age <5 years)______________________________

____

The date of birth (day/month/year) is especially important. If the date is not documented, ask the mother. If she does not know the date, ask her questions to determine the date as closely as possible; for example, ask when the birth occurred in relation to a local event or holiday.

The gestational age at birth, i.e., the number of weeks of pregnancy may be recorded in the child's birth record. If not, ask the mother and record whether the baby was term (37–41 completed weeks of pregnancy), pre-term (before 37 weeks), or post-term (42 weeks or more).

Ask and record whether the child was a single or multiple birth. Record other data related to the child's birth if documented, for example weight, length and head circumference at birth.

Ask the mother about the child's birth rank, i.e., order. For example, ask if this is your first child, second child, etc.? Include all live births in order, even if an older sibling has died. For example, if the child is the second-born, but the older sibling has died, you would still record the birth rank as 2nd.

If the mother has had other children after this child, ask when her next younger child was born.

Depending on the child's age, ask appropriate questions to determine whether the child is still breastfeeding – either exclusively or with other foods and fluids. If other foods or fluids have been introduced, ask and record the age at which they were introduced. If the child is no longer breastfeeding, ask and record the age at termination of breastfeeding (Refer Figure 14.2).

NOTES

Ask about any adverse events that may affect the child's health. For example, ask 'Are there any events that have happened, such as a death of a family member or caregiver that could affect the child's physical or emotional health?' Also ask when these events occurred.

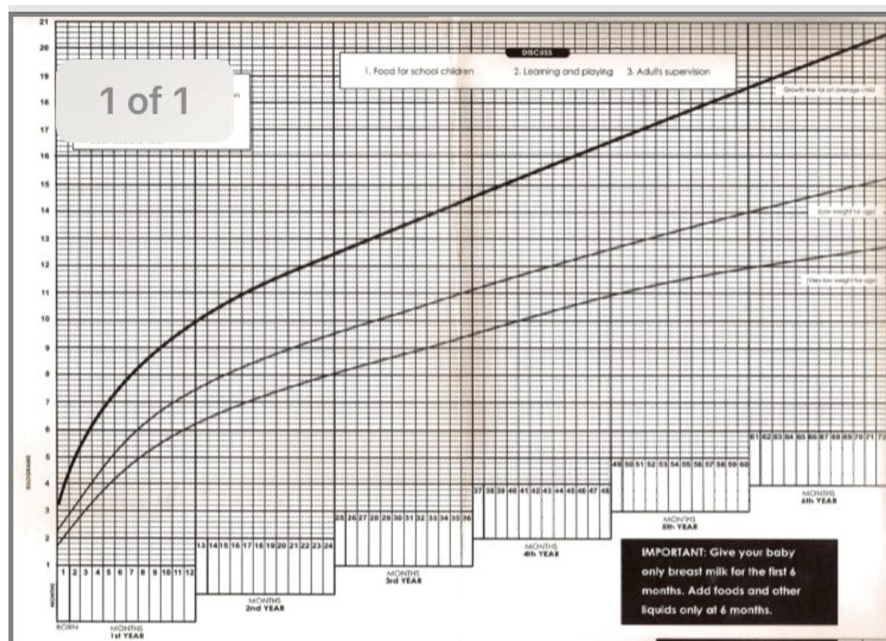


Fig. 14.2 *Feeding a Child*

Record Reason for Visit and Child's Age Today

In the visit notes section of the growth record, record today's date (day, month and year). Ask the mother about the reason for the child's visit and record the reason in the visit notes (for example, immunization, check-up or illness). If the child is ill, take care of the immediate concerns before continuing the growth assessment process.

It is important to know the precise age of the child in order to assess certain growth indicators. Determine the age of the child today by using a computerized system (if available) or a child age calculator, a disk that is turned to calculate a child's age in completed weeks or months in the first year of life. If the child is more than a year old, you will need to mentally calculate the child's completed years and then use the disk to determine the number of additional months completed beyond the completed years. Where the exact date of birth is unknown, a local events calendar could be used to establish the child's likely date of birth. A WHO child age calculator is shown below in Figure 14.3.

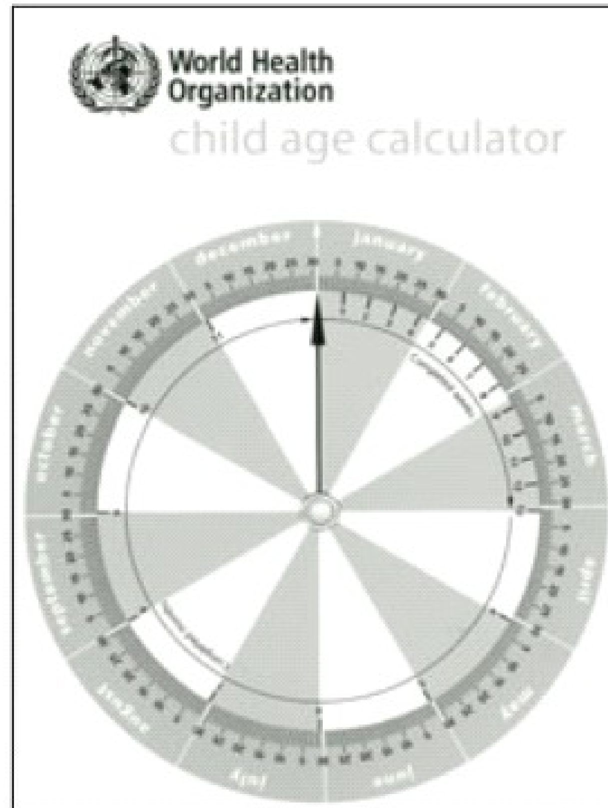


Fig. 14.3 WHO Child Age Calculator

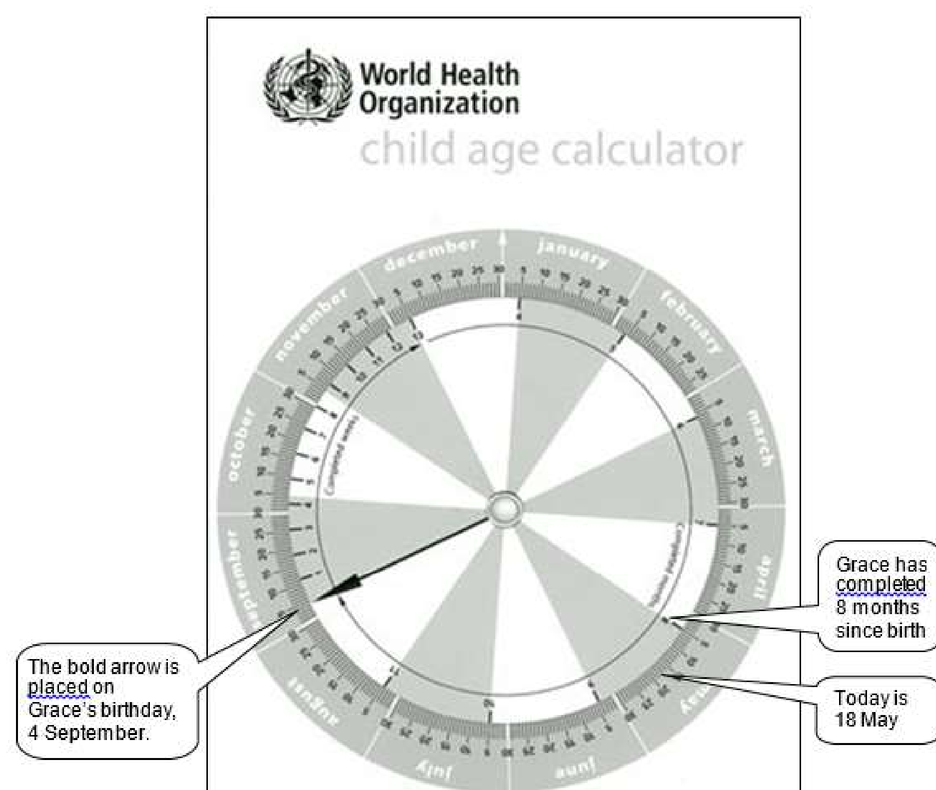
Instructions for Use a Child Age Calculator

- Determine the child's date of birth. This date should be recorded in the growth record on Page 1, i.e., Personal Data.
- Determine and note down the number of full years the child has completed, for example ask the mother how many birthdays have been celebrated if this is a local custom. (Note: Simply subtract the year of birth from the current year that will be accurate only if the child has already had a birthday this year).
    - o If the child is one or more years old, turn the disk to calculate the number of additional months completed.
    - o If the child is less than one year old, use the disk to count the number of weeks (in the first 3 months) or months (from 3–11 months) completed since birth.
- Turn the disk until the bold arrow points to the child's birthday (month and day) on the stationary circular calendar.
- Locate today's date on the stationary calendar and count on the rotating disk how many months (or weeks if less than 3 months old) the child has completed since birth or the last birthday.

NOTES

- Record the child's age today in the visit notes of the growth record. Use abbreviations agreed upon for year, month, and week.
  - If the child is more than 1 year old, record completed years and months, for example, 1 year 6 months, 2 year 3 months. If no months have been completed beyond the child's birthday, record as 1 year 0 month, 2 year 0 month, etc.
  - If the child is between 3 months and 1 year old, record completed months, for example, 4 month, 11 months.
  - If the child is less than 3 months old, record completed weeks, for example, 9 week. Notice that 13 weeks = 3 months.
  - If the child was born on 29 February, place the bold arrow on 28 February.

Example 1: Grace Madu is seen at a clinic on 18 May 2006. Her mother has brought her for immunization. Grace's date of birth is already recorded on the personal data page of her girl's growth record as 4 September 2005. She has not yet completed one year since birth.



To determine Grace's age in completed months, the health care provider turns the disk on the age calculator until the bold arrow points to her birthday, 4 September. He then locates the current date on the circular calendar. He notes that 8 months have been completed since Grace's birthday.

In the visit notes section of the growth record the health care provider writes Grace's age as 8 months and the reason for visit as immunization.

Select Pages of the Growth Record to Use at this Visit

NOTES

You will use the visit notes at every visit to record the date, child's age, measurements, reason for visit, observations, recommendations, as well as notes on feeding history, any problems, and counselling given. In addition, you may use other pages of the growth record appropriate for the child's age, including the following:

- Growth Charts: Select the four charts to use based on the child's age at a given visit. Refer to the table of contents at the beginning of the growth record to make the selection. Growth indicators will be plotted on the selected charts.
- Feeding Recommendations: Use the recommendations for the child's current or next age group.
- Care Messages: As needed, use the messages that are appropriate at all times as well as messages about emotional development, communication and movement for the child's current or next age group.
- Recommended National Immunization Schedule: Refer to this page to determine whether a child is due for an immunization. This page will vary by country. Record dates that any immunizations are given and the date of the next scheduled immunization.
- Other National Program Recommendations: This page will vary according to national recommendations. Record any recommended supplements given, procedures done, etc.

Example 2: For Grace Madu, the 8-month-old girl described earlier, the health care provider will use the following four growth charts in the Girl's Growth Record:

- Length for age, girls, 6 months to 2 year
- Weight for age, girls, 6 months to 2 years
- Weight for length, girls, birth to 2 years
- BMI for age, girls, 6 months to 2 years

Depending on the results of Grace's growth assessment and the time available, the health care provider may discuss with the mother feeding recommendations suitable for a child who is 8 months of age.

Exercise A: To determine a child's age, selecting growth charts to use in the growth record.

In this exercise you will determine the age of several children using the WHO child age calculator. Then you will determine which growth charts in the growth record should be used during the child's growth assessment.

NOTES

Answer the questions about each case described below:

1. On 30 June 2006, Mrs. Ismail brings her son Salaam to the health center because he has ear pain. The personal data page in Salaam's boy's growth record says that he was born on 12 September 2004.

   What is Salaam's age today, as it should be recorded in the visit notes of the boy's growth record?

   After weighing and measuring Salaam and recording his weight and length in the visit notes, which four growth charts from the growth record should the health care provider use for Salaam's growth assessment?

   Title of Growth Chart: Page Number:

2. On 19 April 2006, a girl named Ruby is seen at the health center for a well-child visit. Ruby's grandmother says that Ruby's girl's growth record has been lost. She says that Ruby will celebrate her first birthday soon, on the first day of May. The health care provider begins a new girl's growth record for Ruby by completing the personal data page.

   What is Ruby's date of birth, as it should be recorded on the personal data page? What is Ruby's age today, as it should be recorded on the visit notes page?

   After weighing and measuring Ruby and recording her weight and length in the visit notes, which four growth charts should the health care provider use?

   Title of Growth Chart: Page Number:

3. On 20 August 2006, a baby boy named Ivan is brought to the health center for immunization. The boy's birth record says that he was born on 26 May 2006. The health care provider begins a boy's growth record for Ivan by completing the personal data page. He then turns to the visit notes page to record Ivan's age today.

   What is Ivan's age today, as it should be recorded on the Visit Notes page?

   After weighing and measuring Ivan and recording his weight and length in the visit notes, which four growth charts should the health care provider use?

   Title of Growth Chart: Page Number:

Exercise B: Continuing Case Studies – Nalah and Toman

In this exercise, you will begin a growth record for a girl named Nalah and one for a boy named Toman. You have been given a girl's growth record and a boy's growth record to use in this and other exercises about Nalah and Toman.

Read the information about each child below and follow the instructions given.

Nalah

Nalah Parab was born on 7 February 2006. She was a single, term birth (38 weeks of pregnancy). According to her birth record, her weight was 2.9 kg and length was 49 cm. Her head circumference was not measured.

Nalah's parents are Hamid and Shira Parab. Their address is at 40 Rim Road. Nalah is the first and only child born to her mother. She is breastfed, but she has also been taking some water since she was 3 weeks old. There have been no unusual adverse events in her life so far.

The date of Nalah's visit to the health centre is 25 March 2006. Her mother has brought her for immunization.

Instructions

- Complete the personal data page of the girl's growth record for Nalah. (You may make up a record number).
- In the visit notes section of the girl's growth record, record Nalah's date of birth. On the first row, enter the date of Nalah's visit, her age today, and the reason for her visit.
- List below the titles and page numbers of the four growth charts that the health care provider should use during Nalah's growth assessment.

Toman

Toman Baruni comes to the health centre with his mother, Salwa Baruni, on 15 August 2006 for a well-child visit. Mrs Baruni thinks that it must be time for Toman to have another immunization, but she has lost his growth record, so she is not sure. She says that his last visit to the health centre was at 6 months, and he had received all of his immunizations at that point.

In order to start a new boy's growth record, the health care provider asks Mrs Baruni about Toman's birth. Mrs Baruni says that Toman was born on 10 July 2005. He was a single, term birth and weighed 3.5 kg. She does not remember his length or head circumference.

Mrs Baruni was sick at Toman's birth, and Toman was given infant formula by the nurses for 3 days in the hospital. After leaving the hospital Mrs Baruni breastfed Toman, but she stopped after 3 months.

Toman is Mrs Baruni's second child. He lives with her at 100 Centre Street, Apartment 22. Mrs Baruni's first child was born of a different husband and lives with him. Toman has no younger siblings. Mrs Baruni is separated from Shaka Baruni, but Toman spends weekends with his father. Mrs Baruni does not think that the separation has been traumatic for Toman.

Instructions

- Complete the personal data page of the boy's growth record for Toman. (You may make up a record number).

NOTES

- Above the visit notes section of the boy's growth record, record Toman's date of birth for easy reference. On the first row, enter the date of Toman's visit, his age today, and the reason for his visit.
- List below the titles and page numbers of the four growth charts that the health care provider should use during Toman's growth assessment.

Growth Monitoring Chart

A high standard example of growth monitoring chart from India

Three steps for appropriate plotting are (Refer Figure 14.4):

- Find the Child's Age on Chart
- Find the Child's Weight on the Chart
- Draw the Growth Curve

Find the Child's Age on Chart: The first box called born on the horizontal axis should be filled with the name of the month the child was born, i.e., March. All the other boxes should be filled with the subsequent months, i.e., April, May, June, etc.

Based on the month, mark a straight dotted line up the middle of the column.

Find the Child's Weight on the Chart: The vertical axis of growth chart indicates the weight of the child in kilos. Based on the child's weight, follow the horizontal faint lines across corresponding to the child weight (to the nearest 100g) across the card until it crosses the right month column. Put a dot in the middle of the column representing the month of weighing.

Draw the Growth Curve: Draw a line from the previous dot, if any, to the new one to make the child's growth curve.

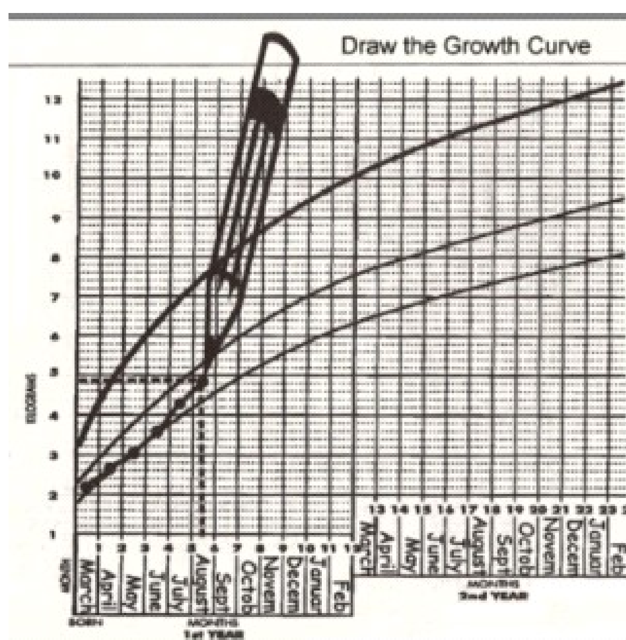


Fig. 14.4 *Growth Curve*

NOTES

Observe the Child and Note Clinical Signs of Marasmus and Kwashiorkor

When a child is undressed to prepare for weighing, certain clinical signs of severe undernutrition may be apparent. It is important to recognize signs of Marasmus and Kwashiorkor since they require urgent specialized care that may include special feeding regimens, careful monitoring, antibiotics, etc. Regardless of their weight, children with these syndromes should be referred for urgent care.

Marasmus (Non-Oedematous Malnutrition): In this form of severe undernutrition, the child is severely wasted and has the appearance of skin and bones due to loss of muscle and fatty tissue. The child's face looks like an old man's following loss of facial subcutaneous fat, but the eyes may be alert. The ribs are easily seen. There may be folds of skin on the buttocks and thighs that make it look as if the child is wearing baggy pants. Weight for age and weight for length/height are likely to be very low (Refer Figure 14.5).

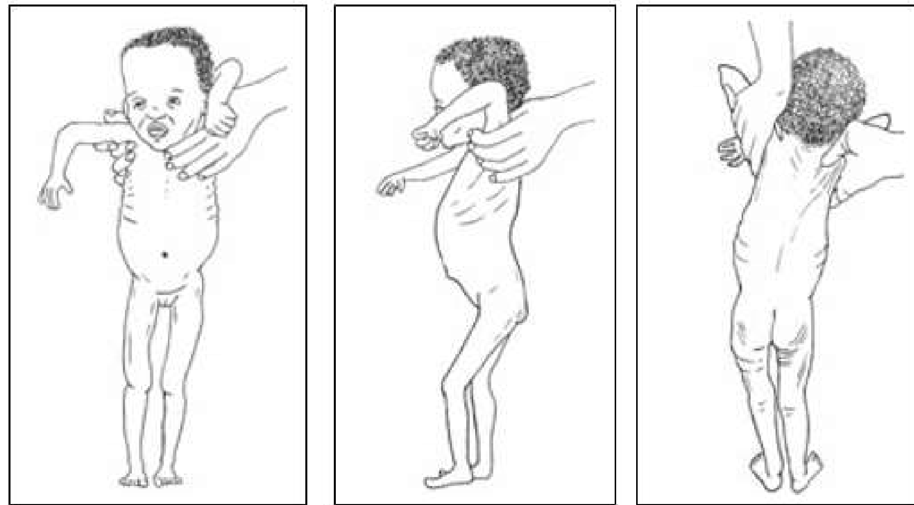


Fig. 14.5 *Child Suffering from Marasmus*

Kwashiorkor (Oedematous Malnutrition): In this form of severe undernutrition, the child's muscles are wasted, but the wasting may not be apparent due to generalized oedema (swelling from excess fluid in the tissues). The child is withdrawn, irritable and ill and will not eat. The face is round (because of oedema) and the hair is thin, sparse and sometimes discoloured. The skin has symmetrical discoloured patches where the skin later cracks and peels off. A child with kwashiorkor will usually be underweight, but the oedema may mask the true weight.

Marasmic Kwashiorkor: Kwashiorkor and Marasmus are distinct conditions, but in communities where both occur, cases of severe undernutrition often have features of both. For example, a child may have severe wasting as seen in marasmus, along with the skin and hair changes or oedema typical in kwashiorkor. The child's upper body is wasted, but the lower limbs are swollen with oedema.

Oedema of Both Feet: Oedema of both feet is a sign that a child needs referral, even if other signs of kwashiorkor are not present. The oedema must

appear in both feet. (If the swelling is in only one foot, it may just be a sore or infected foot). To check for oedema, grasp the foot so that it rests in your hand with your thumb on top of the foot. Press your thumb gently for a few seconds. The child has oedema if a pit (dent) remains in the foot when you lift your thumb (Refer Figure 14.6).

A child with oedema of both feet is automatically considered severely underweight, regardless of what the scale shows. You should weigh and measure the child, but do not determine a BMI based on the weight. Note the weight, length/height, and the oedema in the visit notes. When plotting the child's measurements, indicate on the graphs, near the relevant points, that the child has oedema.



Fig. 14.6 *Oedema of Both Feet*

Recording Other Observations

Other observations about the child's appearance may also be recorded in the visit notes before weight and length/height are measured. The following terms may be useful in recording your observations. Keep in mind, however, that some of these terms have more technical definitions based on the child's charted weight for length/height and BMI for age.

Terms for recording observations about the child's appearance:

- Wasted (too thin)
- Lean (fleshed out, no noticeable fat)
- Normal (rounded contours, no noticeable excess fat)
- Heavy (sturdy, mostly muscular, not lean or thin)
- Overweight (noticeable fat)
- Obese (excess fat)

Measure Weight

It is recommended to weigh children using a scale with the following features:

- Solidly built and durable
- Electronic, i. e., digital reading

- Measures up to 150 kg
- Measures to a precision of 0.1 kg (100g)
- Allows tared weighing

NOTES

Tared weighing means that the scale can be reset to zero (tared) with the person just weighed still on it. Thus, a mother can stand on the scale, be weighed, and the scale tared. While remaining on the scale, if she is given her child to hold, the child's weight alone appears on the scale. Tared weighing has two clear advantages:

- There is no need to subtract weights to determine the child's weight alone (reducing the risk of error).
- The child is likely to remain calm when held in the mother's arms for weighing.

There are many types of scales currently in use. The Uniscale made by United Nations Children's Fund (UNICEF) has the recommended features listed above and is used in this course to demonstrate weighing techniques (Refer Figure 14.7).

It is powered by a lithium battery that is good for a million measurement sessions. The scale has a solar on-switch, so it requires adequate lighting to function. Footprints may be marked on the scale to show where a person should stand.

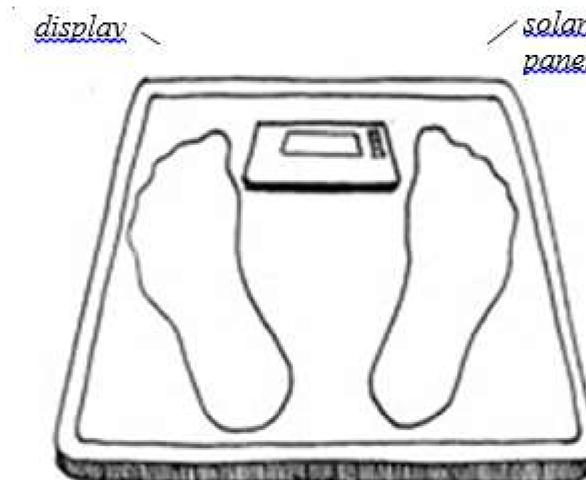


Fig. 14.7 *Uniscale*

A taring scale is easy to use and reliable. However, there are other types of scales that may be reliable, for example an electronic baby scale, or a paediatric beam balance that has been calibrated. Children who can stand alone can be weighed standing on a scale. Otherwise, the mother can be weighed alone; then the mother and child can be weighed together and the mother's weight subtracted to determine the child's weight (Refer Figure 14.8).

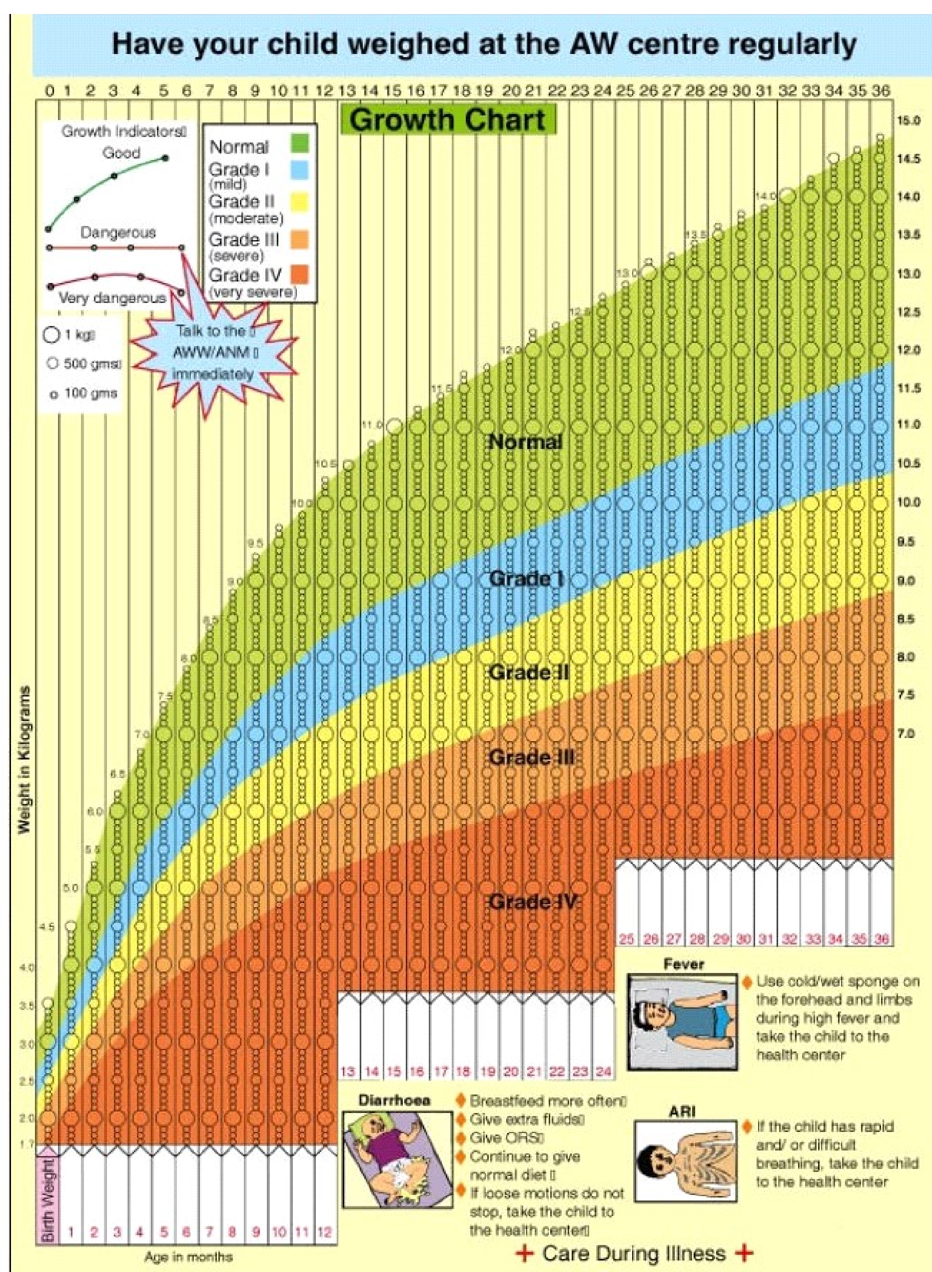


Fig. 14.8 *Growth Chart*

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Prepare for Weighing

Explain to the mother the reasons for weighing the child, for example to see how the child is growing, how the child is recovering from a previous illness, or how the child is responding to changes that have been made in his feeding or care.

If the child is less than 2 years old or is unable to stand, tared weighing should be done. Explain the tared weighing procedure to the mother as follows. Stress that the mother must stay on the scale until her child has been weighed in her arms.

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- The mother will remove her shoes and step on the scale to be weighed alone first. She may need to adjust any long garments that could cover the display and solar panel of the scale.
- After the mother's weight appears on the display, tell her to remain standing on the scale. Reset the reading to zero by covering the solar panel of the scale (thus blocking out the light).
- Then give the mother her child to hold.
- The child's weight will appear on the scale.
- Record the child's weight.

If the child is 2 years or older, you will weigh the child alone if the child will stand still. Explain that the child will need to step on the scale alone and stand very still.

Undress the child because child needs to remove outer clothing in order to obtain an accurate weight. A wet diaper, or shoes and jeans, can weigh more than 0.5 kg. Babies should be weighed naked; wrap them in a blanket to keep them warm until weighing. Older children should remove all but minimal clothing, such as their underclothes.

If it is too cold to undress a child, or if the child resists being undressed and becomes agitated, you may weigh the clothed child, but note in the growth record that the child was clothed. It is important to avoid upsetting the child so that the length/height measurements can also be taken.

If it is socially unacceptable to undress the child, remove as much of the clothing as possible.

Note: If the child has braids or hair ornaments that will interfere with length/height measurements, remove them before weighing to avoid delay between the measurements. Especially with young children whose length will be measured, it is important to move quickly and surely from the scale to the length board to avoid upsetting the child.

Weigh a Child Using Tared Weighing

Be sure that the scale is placed on a flat, hard, even surface. It should not be placed on a loose carpet or rug, but a firm carpet that is glued down is acceptable. Since, the scale is solar powered, there must be enough light to operate the scale (Refer Figures 14.9, 14.10, 14.11).

- To turn on the scale, cover the solar panel for a second. When the number 0.0 appears, the scale is ready.
- Check to see that the mother has removed her shoes. You or someone else should hold the naked baby wrapped in a blanket.
- Ask the mother to stand in the middle of the scale, feet slightly apart (on the footprints, if marked) and remain still. The mother's clothing must not cover

NOTES

the display or solar panel. Remind her to stay on the scale even after her weight appears, until the baby has been weighed in her arms.

- With the mother still on the scale and her weight displayed, tare the scale by covering the solar panel for a second. The scale is tared when it displays a figure of a mother and baby and the number 0.0.
- Gently hand the naked baby to the mother and ask her to remain still.
- The baby's weight will appear on the display. Record this weight in the visit notes of the child's growth record. Be careful to read the numbers in the correct order (as though you were viewing while standing on the scale rather than upside-down).

Note: If a mother is very heavy, for example more than 100 kg and the baby's weight is relatively low, for example less than 2.5 kg, the baby's weight may not register on the scale. In such cases, have a lighter person hold the baby on the scale.

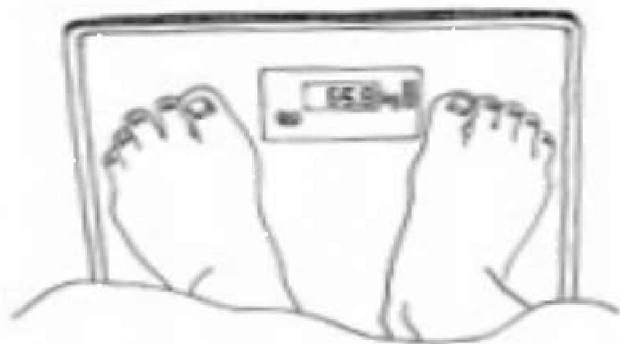


Fig. 14.9 *Mother's Weight Alone*

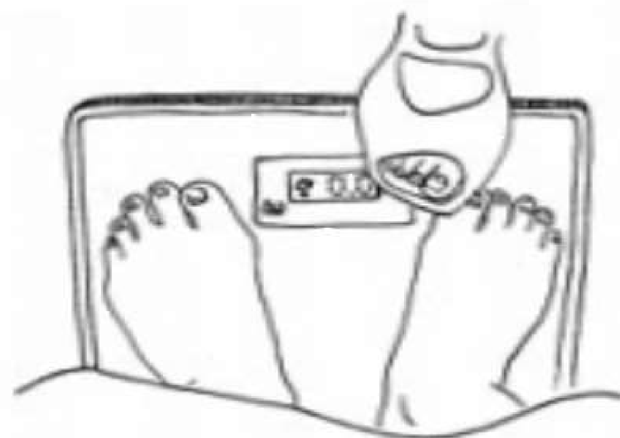


Fig. 14.10 *Taring the Scale*

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Fig. 14.11 *Baby's Weight Appears on Display*

***Note**:* The scale pictured above weighs with a precision to the nearest 0.1 kg. Precision describes the smallest exact unit that the scale can measure. The accuracy of the measurements, however depends on whether the scale is calibrated and whether the observer reads the display correctly.

Weigh a Child Alone

If a child is 2 years old or older and will stand still, weigh the child alone. Ask the mother to help the child remove shoes and outer clothing. Talk with the child about the need to stand still. Communicate with the child in a sensitive, non-frightening way (Refer Figure 14.12).

- To turn on the scale, cover the solar panel for a second. When the number 0.0 appears, the scale is ready.
- Ask the child to stand in the middle of the scale, feet slightly apart (on the footprints, if marked), and to remain still until the weight appears on the display.
- Record the child's weight to the nearest 0.1 kg.

If the child jumps on the scale or will not stand still, you will need to use the tared weighing procedure instead.

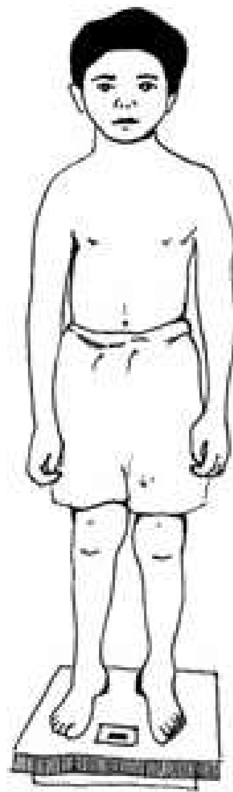


Fig. 14.12 *Weighing a Child Alone*

Measure Length or Height

Depending on a child's age and ability to stand, measure the child's length or height. A child's length is measured lying down (recumbent). Height is measured standing upright.

- If a child is less than 2 years old, measure recumbent length.
- If the child is aged 2 years or older and able to stand, measure standing height.

In general, standing height is about 0.7 cm less than recumbent length. This difference was taken into account in developing the WHO growth standards used to make the charts in the growth record. Therefore, it is important to adjust the measurements if length is taken instead of height, and vice versa.

- If a child less than 2 years old will not lie down for measurement of length, measure standing height and add 0.7 cm to convert it to length.
- If a child aged 2 years or older cannot stand, measure recumbent length and subtract 0.7 cm to convert it to height.

Equipment needed to measure length is a length board (sometimes called an Infantometer) which should be placed on a flat, stable surface, such as a table

(Refer Figure 14.13). To measure height, use a height board (sometimes called a Stadiometer) mounted at a right angle between a level floor and against a straight, vertical surface, such as a wall or pillar (Refer Figure 14.14).

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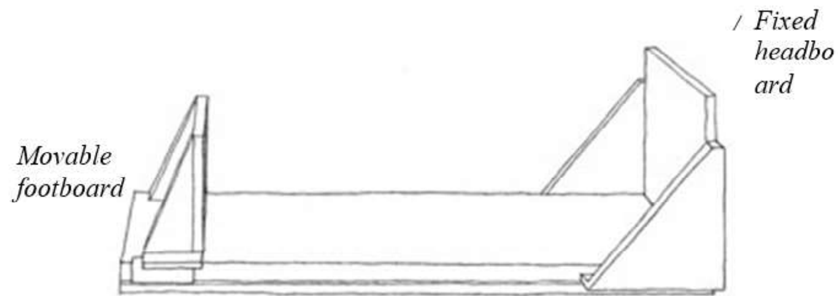


Fig. 14.13 Length Board

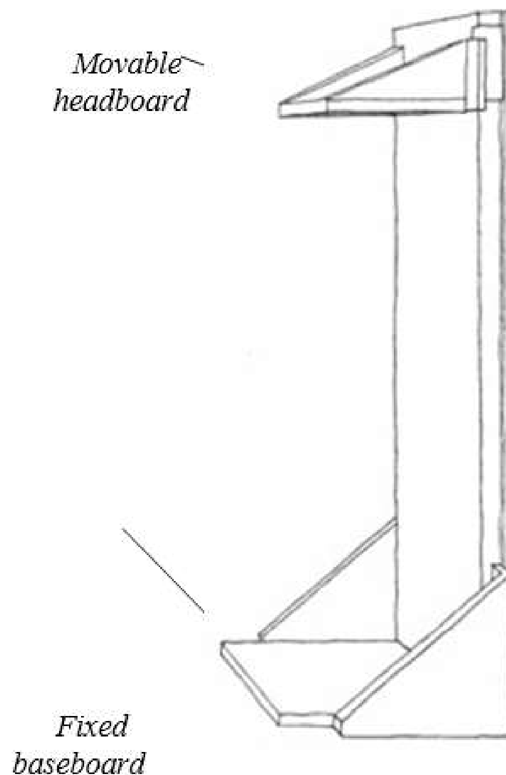


Fig. 14.14 Height Board

A good length or height board should be made of smooth, moisture-resistant (varnished or polished) wood. The horizontal and vertical pieces should be firmly joined at right angles. A movable piece serves as the footboard when measuring length or the headboard when measuring height. Unless there is a digital counter, a measuring tape should be fixed firmly in a groove along the length of the board, so that moving parts do not scrape it and rub off the markings.

Prepare to Measure Length or Height

Be prepared to measure length/height immediately after weighing, while the child's clothes are off. Check that the child's shoes, socks, and hair ornaments have been removed. Undo braids if they will interfere with the measurement of length/height.

If a baby is weighed naked, a dry diaper can be put back on to avoid getting wet while measuring length. If the room is cool and there is any delay, keep the child warm in a blanket until length/height can be measured.

Whether measuring length or height, the mother is needed to help with measurement and to soothe and comfort the child. Explain to the mother the reasons for the measurement and the steps in the procedure. Answer any questions that she may have. Show her and tell her how she can help you. Explain that it is important to keep the child still and calm to obtain a good measurement.

Measure Length

Cover the length board with a thin cloth or soft paper for hygiene and for the baby's comfort.

Explain to the mother that she will need to place the baby on the length board herself and then help to hold the baby's head in place while you take the measurement. Show her where to stand when placing the baby down, i.e., opposite you, on the side of the length board away from the tape. Also show her where to place the baby's head (against the fixed headboard) so that she can move quickly and surely without distressing the baby (Refer Figure 14.15).

When the mother understands your instructions and is ready to assist:

- Ask her to lay the child on his back with his head against the fixed headboard, compressing the hair.
- Quickly position the head so that an imaginary vertical line from the ear canal to the lower border of the eye socket is perpendicular to the board. (The child's eyes should be looking straight up.) Ask the mother to move behind the headboard and hold the head in this position.



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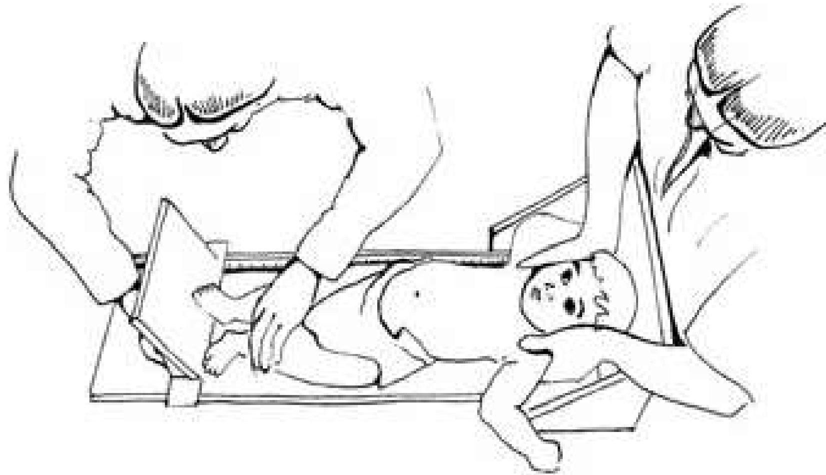


Fig. 14.15 *Measuring Length*

Standing on the side of the length board where you can see the measuring tape and move the footboard:

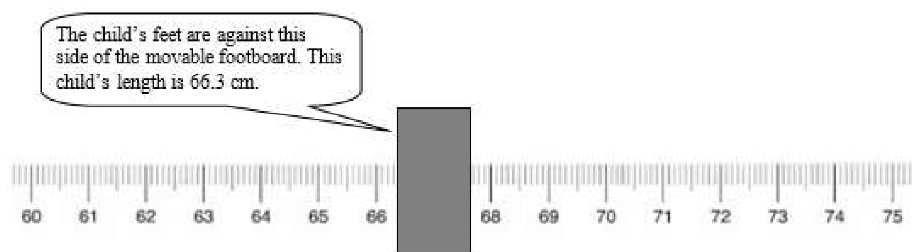
- Check that the child lies straight along the board and does not change position. Shoulders should touch the board, and the spine should not be arched. Ask the mother to inform you if the child arches the back or moves out of position.
- Hold down the child's legs with one hand and move the footboard with the other. Apply gentle pressure to the knees to straighten the legs as far as they can go without causing injury.

  Note: It is not possible to straighten the knees of newborns to the same degree as older children. Their knees are fragile and could be injured easily, so apply minimum pressure. If a child is extremely agitated and both legs cannot be held in position, measure with one leg in position.
- While holding the knees, pull the footboard against the child's feet. The soles of the feet should be flat against the footboard, toes pointing upwards. If the child bends the toes and prevents the footboard from touching the soles, scratch the soles slightly and slide in the footboard quickly when the child straightens the toes.
- Read the measurement and record the child's length in centimetres to the last completed 0.1 cm in the visit notes of the growth record. This is the last line that you can actually see or observe (0.1 cm = 1 mm).

Remember: If the child whose length you measured is 2 years old or more, subtract 0.7 cm from the length and record the result as height in the Visit Notes.

Example 3: Following is a picture of part of a measuring tape. The numbers and longer lines indicate centimetre markings. The shorter lines indicate millimetres. The gray box shows the position of the footboard when a length measurement is taken.

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The child's feet are against this side of the movable footboard. This child's length is 66.3 cm.

Measure Standing Height

Ensure that the height board is on level ground. Check that shoes, socks and hair ornaments have been removed (Refer Figure 14.16).

Working with the mother, and kneeling in order to get down to the level of the child:

- Help the child to stand on the baseboard with feet slightly apart. The back of the head, shoulder blades, buttocks, calves, and heels should all touch the vertical board. This alignment may be impossible for an obese child, in which case, help the child to stand on the board with one or more contact points touching the board. The trunk should be balanced over the waist, i.e., not leaning back or forward.
- Ask the mother to hold the child's knees and ankles to help keep the legs straight and feet flat, with heels and calves touching the vertical board. Ask her to focus the child's attention, soothe the child as needed, and inform you if the child moves out of position.
- Position the child's head so that a horizontal line from the ear canal to the lower border of the eye socket runs parallel to the baseboard. To keep the head in this position, hold the bridge between your thumb and forefinger over the child's chin.
- If necessary, push gently on the tummy to help the child stand to full height.
- Still keeping the head in position, use your other hand to pull down the headboard to rest firmly on top of the head and compress the hair.
- Read the measurement and record the child's height in centimetres to the last completed 0.1 cm in the visit notes of the growth record. This is the last line that you can actually see (0.1 cm = 1 mm).

Remember: If the child whose height you measured is less than 2 years old, add 0.7 cm to the height and record the result as length in the visit notes.

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Fig. 14.16 Measure Standing Height

Care for Measurement Equipment

Proper care for the scale and length/height boards is important to ensure that measurements are as accurate as possible. Keep the equipment clean and store it at normal indoor temperature, protected from humidity and wetness.

The Uniscale will not function if it is too hot or if there is too little light. If the scale is hot, let it cool. If there is not enough light, move closer to a light source. When taring the scale, do not rub the solar panel with your foot or it will become worn; instead, simply block the light by covering it.

The accuracy of equipment should be checked at the time of purchase. Thereafter, check the scale and measuring boards at least once weekly, for example every Monday or Saturday.

To check the scale:

- Weigh known weights of 3, 5, 10, and 20 kg.
- Check tared weighing by weighing a 20 kg weight, taring the scale, and then adding a 3 kg weight. The 3 kg weight should be displayed.
- If the weights are not accurate, calibrate the scale if possible. Otherwise, if the error is consistent, for example off by +0.2 kg consistently, adjust measurements accordingly, for example by subtracting 0.2 kg. Monitor the situation, as the amount of error may change. If measurements are off by variable amounts, notify the responsible officer that the scale needs to be replaced.

Determine Body Mass Index (BMI)

Body Mass Index (BMI) is a number that associates a person's weight with his or her height/length. BMI can be a useful growth indicator when it is plotted on a graph against a child's age. BMI is calculated as follows:

Weight in kg ÷ squared length/height in meters.

Another way to show the formula is kg/m2. (If the measurements are recorded in pounds and inches, convert them to metric units before calculating BMI: 1 inch = 2.54 cm or 0.0254 m, and 1 pound = 0.4536 kg.) BMI is rounded to one decimal place.

It is very important to use a length measurement for a child less than 2 years old and a height measurement for a child age 2 years or older. If necessary, convert height to length (by adding cm) or length to height (by subtracting 0.7 cm) before determining the child's BMI.

If you have a calculator with an x^2 button, it is relatively simple to calculate a child's BMI as follows:

- Type in the weight in kg (to the nearest 0.1 kg).
- Press the / or ÷ sign.
- Type in the length or height in metres. (This will require expressing centimetres as metres; for example, 82.3 centimetres is expressed as 0.823 metres.)
- Press the x^2 button. The height squared is displayed.
- Press the = button. The BMI is displayed.
- Round the BMI to one decimal place and record the BMI on the visit notes page of the growth record.

If your calculator lacks an x^2 button, follow Steps 1-3, repeat Steps 2 and 3, and then press the = button to display the BMI. If you have no calculator, consult a table that shows BMIs for various weights and lengths or heights.

To use the BMI table:

- Find the child's length or height (in centimetres) in the far left column of the table. If the exact measurement is not shown, select the closest one. If the child's measurement is halfway between those shown, select the next higher measurement.
- Look across the row to find the child's weight. If the exact weight is not shown, select the closest one. If the weight is halfway between those shown, consider it on the line.
- Trace your finger upward from the weight to find the child's BMI on the top row of the table. (Or you can trace downward, as the BMIs are also on the bottom row). If the weight was on the line, the BMI will be halfway between those shown, for example 15.5 if between 15 and 16.
- Record the BMI on the Visit Notes page of the Growth Record.

Exercise C: Continuing Case Studies – Nalah and Toman

In Exercise B you began a girl's growth record for Nalah and a boy's growth record for Toman. In this exercise you will enter additional information from a series of visits by each child on the visit notes page, and determine age and BMI at each visit. You may use either a calculator or the BMI table to determine BMI.

Nalah

On the Visit Notes page of Nalah's girl's growth record, you have already recorded some information from her visit of 25 March 2006, when she was 6 weeks old. Open her growth record to the visit notes.

Nalah's weight at 6 weeks was 3.5 kg and her length was 51.3 cm. Record her weight and length at 6 weeks on the visit notes page. Determine her BMI and record it in the visit notes as well.

Following is information from four subsequent visits by Nalah. Enter this information on the visit notes page. Determine Nalah's age and BMI at each visit and enter those as well.

Date of Visit	**Weight**	**Length**	**Reason for Visit**
20 April 2006	4.2 kg	54.8 cm	Immunization
22 May 2006	4.3 kg	54.8 cm	Diarrhoea
26 June 2006	4.8 kg	56.2 cm	Immunization
15 August 2006	5.4 kg	58.1 cm	Well-Baby Visit

Toman

On the visit notes page of Toman's boy's growth record, you have already recorded some information from his visit of 15 August 2006, when he was 1 year and 1 month old. Open his growth record to the visit notes.

- Toman's weight at 1 year and 1 month old was 11.9 kg and his length was 79.0 cm. Record his weight and length at this age on the visit notes page. Determine his BMI and record it as well.
- Following is information from three subsequent visits by Toman. Enter this information on the visit notes page. Determine Toman's age and BMI at each visit and enter those as well.

Date of Visit Weight Length/Height Reason for Visit

15 December 13.5 kg 84.5 cm Well-Child Visit

15 March 2007 15.0 kg 87.0 cm Ear Pain

12 July 2007 16.8 kg 90.9 cm Well-Child Visit

Exercise D: Measuring Weight, Length, and Height

This is a practical exercise in a clinic setting, or in the classroom if children and measuring equipment can be brought there. The mothers should be present, if possible, to tell the children's dates of birth and to assist with measuring and reassuring them.

Your facilitator will assign you to work in pairs. Each pair should do the following steps for at least two children, one who is less than 2 years old and one who is 2–5 years old.

- Review records or ask the mother to determine the child's name, sex, and date of birth.
- Record this information in the inset box below on the left.
- Use the age calculator to determine the child's age today.
- Make a visual assessment of the child (for example, does the child appear thin, fat, active, lethargic).
- Observe the child for signs of marasmus or kwashiorkor. If there is any apparent oedema, test for oedema of both feet.
- Weigh the child.
- Measure the child's length or height.
- Record results on the visit notes page below.
- Calculate the BMI and record it below. You may use the BMI table or a calculator to determine the BMIs

	Date		Measurements (Record below; then plot on charts)			Reason for Visit, Observations, Recommendations
			Weight (kg)	Length/ Height (cm)	BMI	
Child 1: *Sex:* *DOB:*						
Child 2: *Sex:* *DOB:*						
Child 3: *Sex:* *DOB:*						
Child 4: *Sex:* *DOB:*						

NOTES

Check Your Progress

1. Why does the child's age, sex and measurements of weight and length or height is used to calculate?
2. What is a growth record booklet?
3. Give the different steps that can be used to explain a mother for recording the growth of the child.
4. Name the steps that are used for appropriate plotting.
5. What is Marasmus?
6. Define Kwashiorkor giving its symptoms.
7. Define oedema giving its symptoms.
8. List the terms used for recording observations of the child's appearance.
9. Give the features that are recommended to weigh children using a scale.
10. What is tared weight?

14.3 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. The child's age, sex and measurements of weight and length or height is used to calculate the following growth indicators:
   - Length/Height for Age
   - Weight for Age
   - Weight for Length/Height
   - Body Mass Index (BMI) for Age
2. A growth record is a booklet that contains all of the charts needed to record and assess the growth of a child from birth up to 5 years of age. A different growth record is needed for boys and girls because boys and girls have different weights and lengths beginning at birth.
3. Depending on the sex of the child, select a boy's growth record or girl's growth record. Show the growth record to the mother and explain the following points:
   - Growth record booklet records the growth and health child.
   - Each time a child is taken for a visit he is weighed and measured, and the measurements are recorded in the booklet.
   - The booklet includes charts on which the child's measurements are plotted in order to assess his or her growth.

NOTES

- It has a schedule of immunizations to show when the child needs to receive immunizations.
- It has recommendations about feeding the child and important points about caring for child at different ages.
- This booklet needs to be kept in a safe place and bring it with you whenever you bring your child to a health facility.

4. Three steps for appropriate plotting are:
   - Find the Child's Age on Chart
   - Find the Child's Weight on the Chart
   - Draw the Growth Curve
5. Marasmus is a form of severe undernutrition, the child is severely wasted and has the appearance of skin and bones due to loss of muscle and fatty tissue. The child's face looks like an old man's following loss of facial subcutaneous fat, but the eyes may be alert. The ribs are easily seen. There may be folds of skin on the buttocks and thighs that make it look as if the child is wearing baggy pants.
6. Kwashiorkor is a form of severe undernutrition, the child's muscles are wasted, but the wasting may not be apparent due to generalized oedema (swelling from excess fluid in the tissues). The child is withdrawn, irritable and ill and will not eat. The face is round (because of oedema) and the hair is thin, sparse and sometimes discoloured. The skin has symmetrical discoloured patches where the skin later cracks and peels off.
7. Oedema of both feet is a sign that a child needs referral, even if other signs of kwashiorkor are not present. The oedema must appear in both feet. (If the swelling is in only one foot, it may just be a sore or infected foot.) To check for oedema, grasp the foot so that it rests in your hand with your thumb on top of the foot.
8. Terms for recording observations about the child's appearance:
   - Wasted (too thin)
   - Lean (fleshed out, no noticeable fat)
   - Normal (rounded contours, no noticeable excess fat)
   - Heavy (sturdy, mostly muscular, not lean or thin)
   - Overweight (noticeable fat)
   - Obese (excess fat)
9. It is recommended to weigh children using a scale with the following features:
   - Solidly built and durable
   - Electronic, i.e., digital reading

- Measures up to 150 kg
- Measures to a precision of 0.1 kg (100g)
- Allows tared weighing

NOTES

10. Tared weighing means that the scale can be reset to zero (tared) with the person just weighed still on it. A taring scale is easy to use and reliable. However, there are other types of scales that may be reliable, for example an electronic baby scale, or a paediatric beam balance that has been calibrated.

14.4 SUMMARY

- The measurements of a child is taken and recorded whenever an infant or child visits a health care provider, for example for an immunization, a well-baby visit, or care during an illness.
- A growth record is a booklet that contains all of the charts needed to record and assess the growth of a child from birth up to 5 years of age.
- A different growth record is needed for boys and girls because boys and girls have different weights and lengths beginning at birth.
- A growth record should be started for each child and kept by the mother. When a child visits the health facility, ask the mother if the child has a growth record.
- If a child's growth record has been left at home, record information on whatever back-up register or record is available at the health facility, and update the child's growth record at the next visit.
- If a child's growth record is lost or destroyed, replace it if supplies permit.
- Growth record booklet records the growth and health child.
- Each time a child is taken for a visit he is weighed and measured, and the measurements are recorded in the booklet.
- Growth record booklet charts on which the child's measurements are plotted in order to assess his or her growth.
- Growth record booklet has a schedule of immunizations to show when the child needs to receive immunizations.
- Growth record booklet has recommendations about feeding the child and important points about caring for child at different ages.
- The page 1 of the growth record is filled with personal data by asking questions about mother and reviewing any relevant documents that the mother may have, such as a health card or birth certificate.
- The gestational age at birth, i.e., the number of weeks of pregnancy may be recorded in the child's birth record.

- Determine the age of the child today by using a computerized system (if available) or a child age calculator, a disk that is turned to calculate a child's age in completed weeks or months in the first year of life.
- You will need to bring visit notes at every visit to record the date, child's age, measurements, reason for visit, observations, recommendations, as well as notes on feeding history, any problems, and counselling given.
- In a growth monitoring chart the first box called born on the horizontal axis should be filled with the name of the month the child was born, i.e., March. All the other boxes should be filled with the subsequent months, i.e., April, May, June, etc.
- The vertical axis of growth chart indicates the weight of the child in kilos. Based on the child's weight, follow the horizontal faint lines across corresponding to the child weight (to the nearest 100g) across the card until it crosses the right month column. Put a dot in the middle of the column representing the month of weighing.
- When a child is undressed to prepare for weighing, certain clinical signs of severe undernutrition may be apparent. It is important to recognize signs of Marasmus and Kwashiorkor since they require urgent specialized care that may include special feeding regimens, careful monitoring, antibiotics, etc.
- Marasmus is a severe undernutrition, the child is severely wasted and has the appearance of skin and bones due to loss of muscle and fatty tissue.
- In marasmus child's face looks like an old man's following loss of facial subcutaneous fat, but the eyes may be alert. The ribs are easily seen.
- Kwashiorkor is a severe undernutrition, the child's muscles are wasted, but the wasting may not be apparent due to generalized oedema (swelling from excess fluid in the tissues).
- In kwashiorkor child is withdrawn, irritable and ill and will not eat. The face is round (because of oedema) and the hair is thin, sparse and sometimes discoloured. The skin has symmetrical discoloured patches where the skin later cracks and peels off.
- A child with kwashiorkor will usually be underweight, but the oedema may mask the true weight.
- Kwashiorkor and Marasmus are distinct conditions, but in communities where both occur, cases of severe undernutrition often have features of both.
- Oedema of both feet is a sign that a child needs referral, even if other signs of kwashiorkor are not present. The oedema must appear in both feet.
- A child with oedema of both feet is automatically considered severely underweight, regardless of what the scale shows.
- Other observations about the child's appearance may also be recorded in the visit notes before weight and length/height are measured.

NOTES

- Tared weighing means that the scale can be reset to zero (tared) with the person just weighed still on it.
- If a child is 2 years old or older and will stand still, weigh the child alone. Ask the mother to help the child remove shoes and outer clothing. Talk with the child about the need to stand still.
- If the child jumps on the scale or will not stand still, you will need to use the tared weighing procedure instead.
- Depending on a child's age and ability to stand, measure the child's length or height.
- A child's length is measured lying down (recumbent). Height is measured standing upright.
- If a child is less than 2 years old, measure recumbent length.
- If the child is aged 2 years or older and able to stand, measure standing height.
- In general, standing height is about 0.7 cm less than recumbent length. This difference was taken into account in developing the WHO growth standards used to make the charts in the growth record. Therefore, it is important to adjust the measurements if length is taken instead of height, and vice versa.
- Ensure that the height board is on level ground. Check that shoes, socks and hair ornaments have been removed.
- Body Mass Index (BMI) is a number that associates a person's weight with his or her height/length. BMI can be a useful growth indicator when it is plotted on a graph against a child's age.

14.5 KEY WORDS

- **Growth record:** A growth record is a booklet that contains all of the charts needed to record and assess the growth of a child from birth up to 5 years of age.
- **Precision:** Precision describes the smallest exact unit that the scale can measure.
- **Infantometer:** Equipment needed to measure length is a length board or sometimes called an infantometer.
- **Stadiometer**: Stadiometer is used to measure height.
- **Body Mass Index (BMI)**: Body Mass Index (BMI) is a number that associates a person's weight with his or her height/length.
- **Marasmus:** Marasmus is a severe undernutrition, the child is severely wasted and has the appearance of skin and bones due to loss of muscle and fatty tissue.

- **Tared weighing**: Tared weighing means that the scale can be reset to zero (tared) with the person just weighed still on it.

14.6 SELF-ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. How is a child's weight measured?
2. Why is growth record useful?
3. What are the steps required to start a new growth record?
4. What is growth monitoring chart?
5. Distinguish between Marasmus and Kwashiorkor.
6. Explain the equipment used to measure the length of a child.
7. What is BMI?

Long-Answer Questions

1. Discuss in detail how growth of infants is measured.
2. Briefly explain about the significance of growth monitoring chart defining the appropriate ways for plotting it.
3. Draw a well labelled diagram of a uniscale.
4. Discuss how a child is prepared for weighing and how a mother should weigh her child using a tared weighing.
5. What is a length board and height board? Draw well labelled diagram of both to explain their differences.
6. Explain the various methods of recording growth of infants.
7. On 30 June 2006, Mrs. Ismail takes her son Salaam to the health centre because he has ear pain. The personal data page in Salaam's boy's growth record says that he was born on 12 September 2004. What is Salaam's age today, as it should be recorded in the visit notes of the boy's growth record? After weighing and measuring Salaam and recording his weight and length in the visit notes, which four growth charts from the growth record should the health care provider use for Salaam's growth assessment?
8. Determine Body Mass Index (BMI) of a child. How BMI table is used and calculated?
9. Describe the procedure of plotting growth of infants.

NOTES

14.7 FURTHER READINGS

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